JULY 14, 1958
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Chemical Engineering

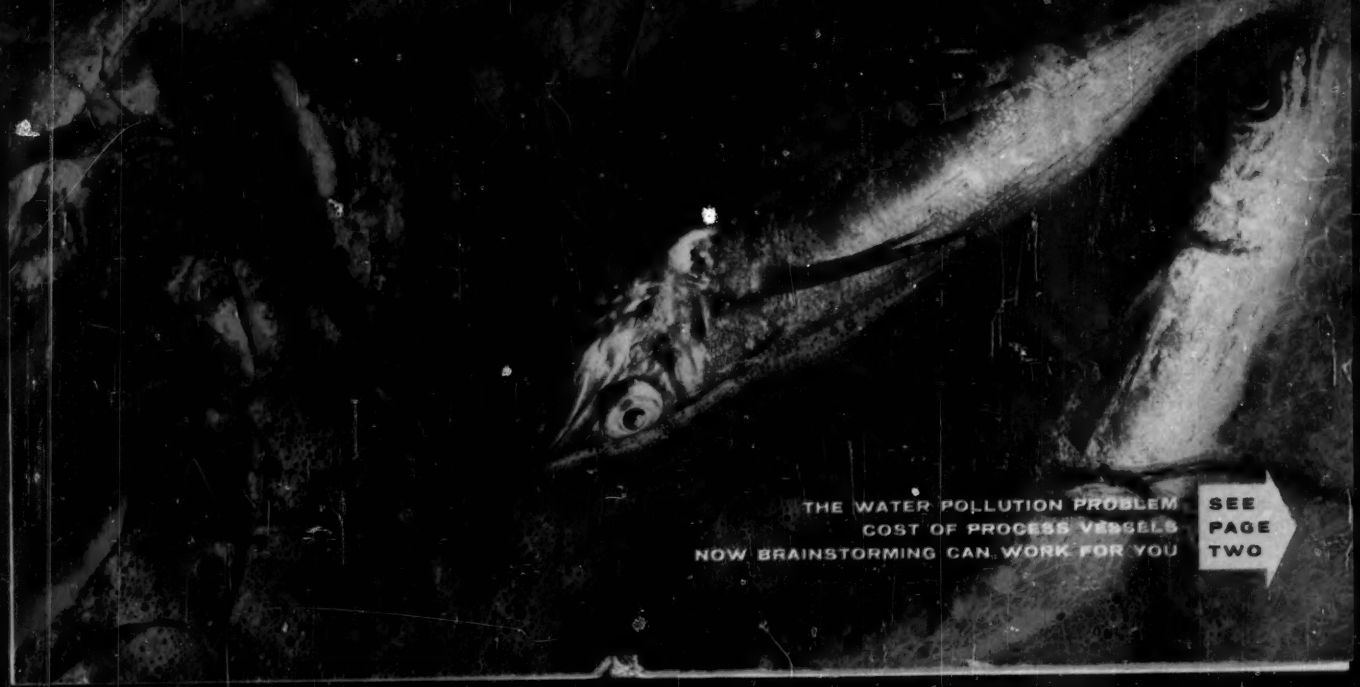
A McGRAW-HILL PUBLICATION

JULY 14, 1958

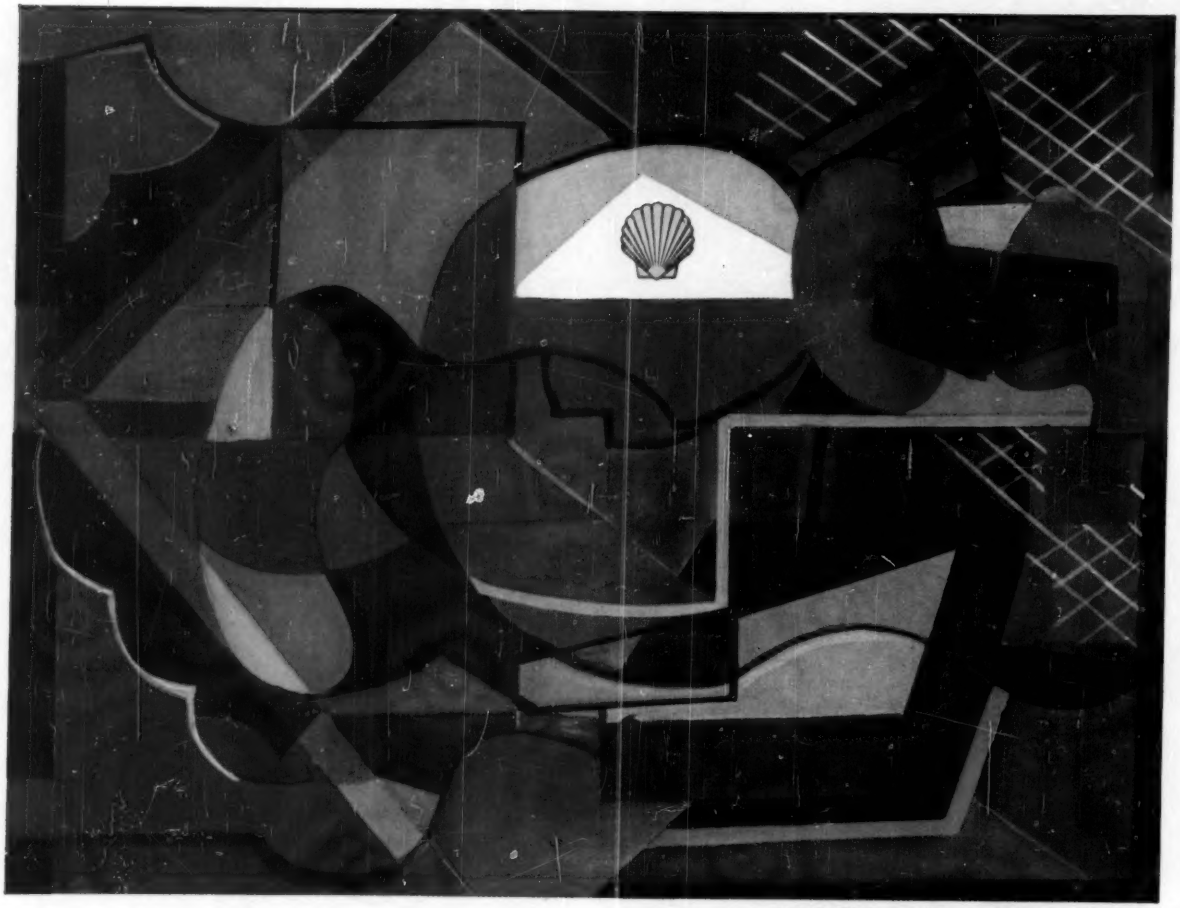
how to cope with

often want to maintain a variable liquid level in- | F. below the liqu one thermocoup desired

WATER POLLUTION



THE WATER POLLUTION PROBLEM
COST OF PROCESS VESSELS
NOW BRAINSTORMING CAN WORK FOR YOU
SEE PAGE TWO



SYNTHESIS—an interpretation by Barton

How can these intermediates help you?

THE Shell Chemical intermediates listed at the right are sources of a whole spectrum of important materials which find use in widely different industries.

The reactivity of each of these intermediates makes possible an extensive chemistry that is well worth your exploration. These products are available for shipment in quantities from a drum to a tank car.

Your Shell Chemical representative will gladly help you investigate these versatile intermediates. Samples and technical literature are available on your letterhead request.

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JULY 14, 1958

JOHN R. CALLAHAM, Editor-in-Chief

Engineered Cost Cutting

Few things can be more dangerous to a company or to an industry than lack of perspective in that operation known as "cost cutting."

Yet today our entire economy is in a serious cost-cutting mood.

And today—just as always—far too many people are thinking only in terms of retreat, contraction, budget slash, wielding the axe. . . .

Danger is that worthwhile expenditures—especially those needed for future profits—are usually cut along with the luxuries simply because so few men know for sure which is which . . . until it's too late!

True cost economy, on the other hand, doesn't save dollars through cutting costs so much as it engineers bigger profits through improving efficiency and raising productivity.

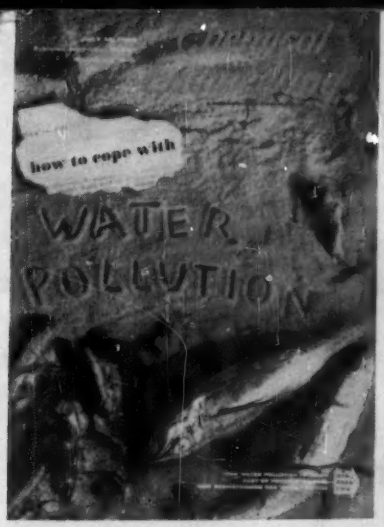
That's where the engineer comes in . . . for only he has the unique combination of engineering approach and economic grasp so vital in evaluating today's complex chemical operations.

The engineer, therefore, is best equipped to realize the full cost-cutting potential of better (not necessarily cheaper) raw materials, equipment, materials of construction, instrumentation.

These areas of economy are particularly attractive today because of the wealth of new and improved products now available from raw materials and equipment suppliers.

Never before have the chemical process industries had such a wealth of top-notch materials to pick from. And it will be many years—if ever—before both availability and prices again become so favorable.

Engineered cost control, not panicky cost cutting, is the key to today's competitive economy . . . and tomorrow's economic survival.



FOURTEENTH OF TWENTY-SIX ISSUES

14/26

GUIDED TOUR

How to cut your plant's contribution to the water pollution problem

A new panel of experts tackles another serious problem for the Stardust Chemical Co. Their water shortage troubles were solved last December. Now it's water pollution. The experts show how a job like this can be licked. See how their experience may be applied to your plant if you need help or guidance. (p. 129)

Continuous reactor is now automated

Even though it's small, this pilot operation is believed to be the first of its kind. Fully automatic control cuts man hours by 90%, gives better data and faster results. (p. 78)

Your best reflux ratio

For any given separation, the greater the reflux, the fewer the trays. Here's a pro-

Chemical

GUIDED TOUR

fessional's method for arriving at the economic optimum. He makes designing easier for you. (p. 144)

When and how to buy used equipment

In the right circumstances, buying used process equipment can save both time and money. Here's the lowdown on the advantages and the pitfalls as well as where to look and how to buy. (p. 141)

Process vessels in your cost file

Glass-lined kettles and tanks are the subjects for your second Cost File. New charts give data on agitated jacketed kettles and on tanks for both corrosive and noncorrosive service. (p. 158)

Now brainstorming can work for you

Beyond the publicity and ballyhoo of brainstorming, there's merit now. Today it's possible to use it for help with many scientific problems. It'll be easy with this clarification of techniques. (p. 155)

CE is edited for the engineer concerned with chemical operations, whatever his function . . . administration, production and plant operations, design and construction, research and development, sales and purchasing. More engineers subscribe to CE than to any other magazine in the field. Print order this issue:

47,504

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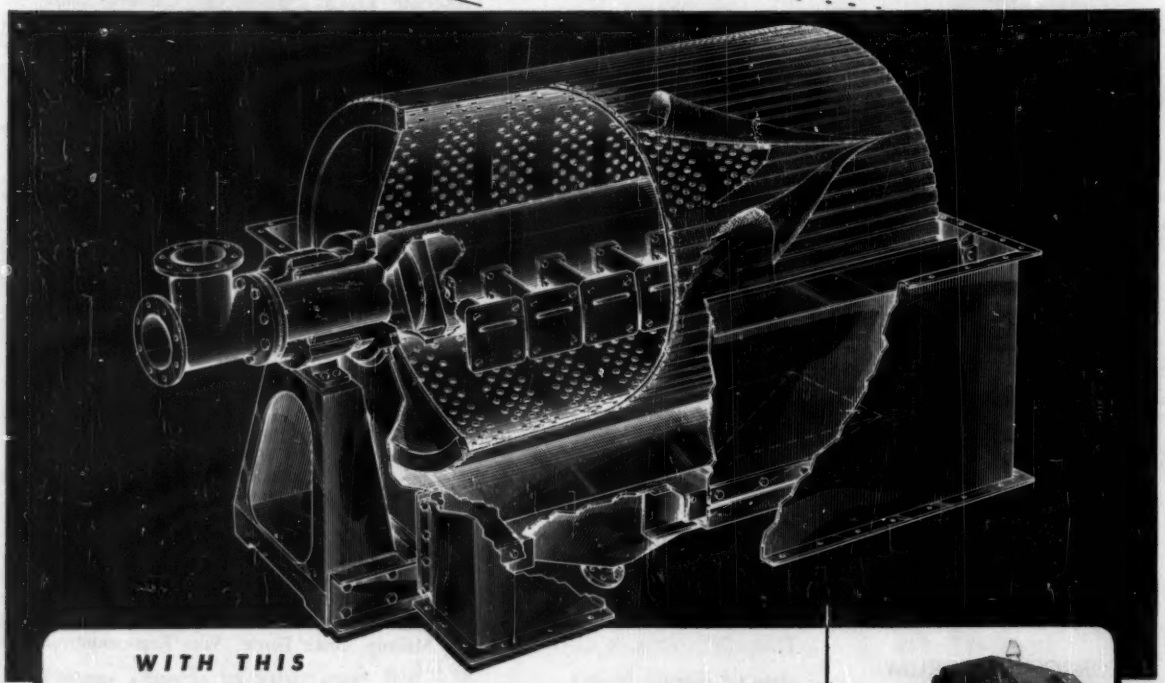
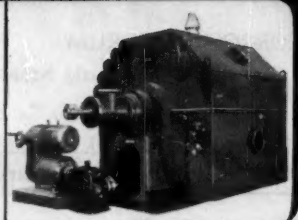


WITH THIS

BIRD-YOUNG

Single Cell, Rotary Vacuum Filter



No other Filter has its Design and Operating Advantages

Gentle puffs of air whisk the cake from the cloth as clean as a whistle. This means that thin cakes can be discharged at high drum speeds. Capacity per foot of filter area is several times that of ordinary filters.

Vacuum is employed directly under the filter medium over virtually the entire drum surface. This means a drier cake and a *better wash.*

Multi-stage, counter-current washing is effected with sharp separation of each wash liquor from the filtrate. The weak wash liquor may be used counter-currently.

The Bird-Young Filter is just the ticket when a *closed system* is desired. It is readily made fume or vapor tight and the vacuum pump discharge recirculated.

You owe it to your product and your reputation for low cost processing to find out what this Bird-Young Filter can do for you. The Bird Research and Development Center is equipped to provide prompt and authentic pilot-scale test data.

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Leading Authority on Solids-Liquids Separations

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- Bird Continuous Centrifugal Separators
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- Bird Suspended Centrifugals • Bird Centrifugal Classifiers
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Butadiene-avgas plant spins off new product 84

Originally, two absorbers were set up to handle butadiene output, then engineers found that one could do the job while the other was freed to concentrate butene-2.

How to tackle water pollution problems 129

When refinery effluent starts souring fishing water, you'd better do something about it before the fishing industry casts a legal line at you. Here's what you can do.

In the market for processing equipment? 141

Be sure you take a close look at second-hand equipment. Here are the advantages you'll cash in on and the pitfalls you should be wary of when you tap this rich source.

Easy route to optimum trays and reflux ratio 144

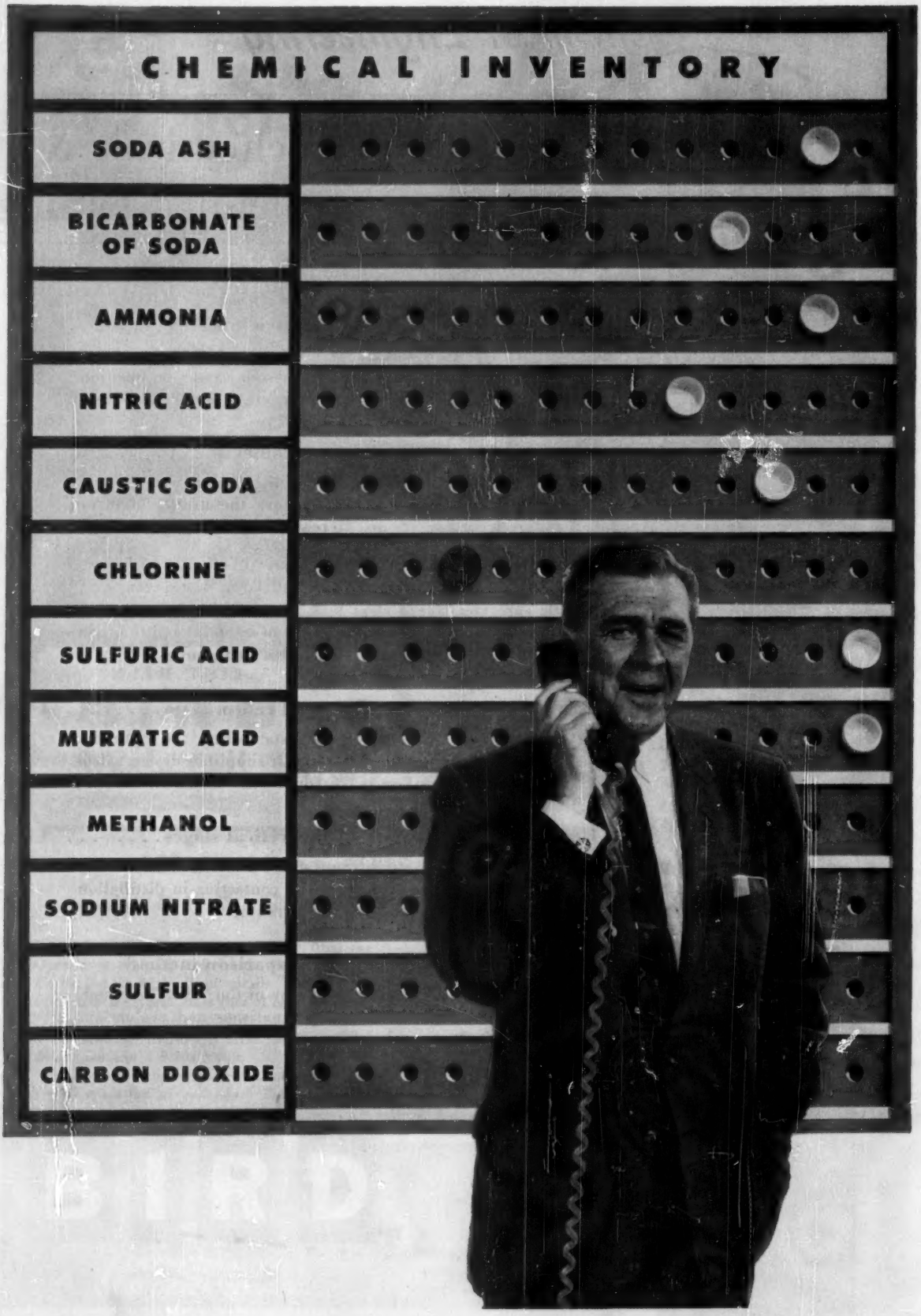
Try this general solution for establishing the optimum number of trays and reflux ratio. It simplifies design calculations and helps you make convenient estimates.

How to find the number of theoretical stages 147

You can apply the equilibrium stage calculations shown here to mass transfer during stage-wise contacting in distillation and absorption, extraction and leaching.

Coming soon: A look at cost comparison methods

Properly and consistently used, any of the "exact" methods for making engineering cost comparisons and evaluations give equivalent results. The article will demonstrate this.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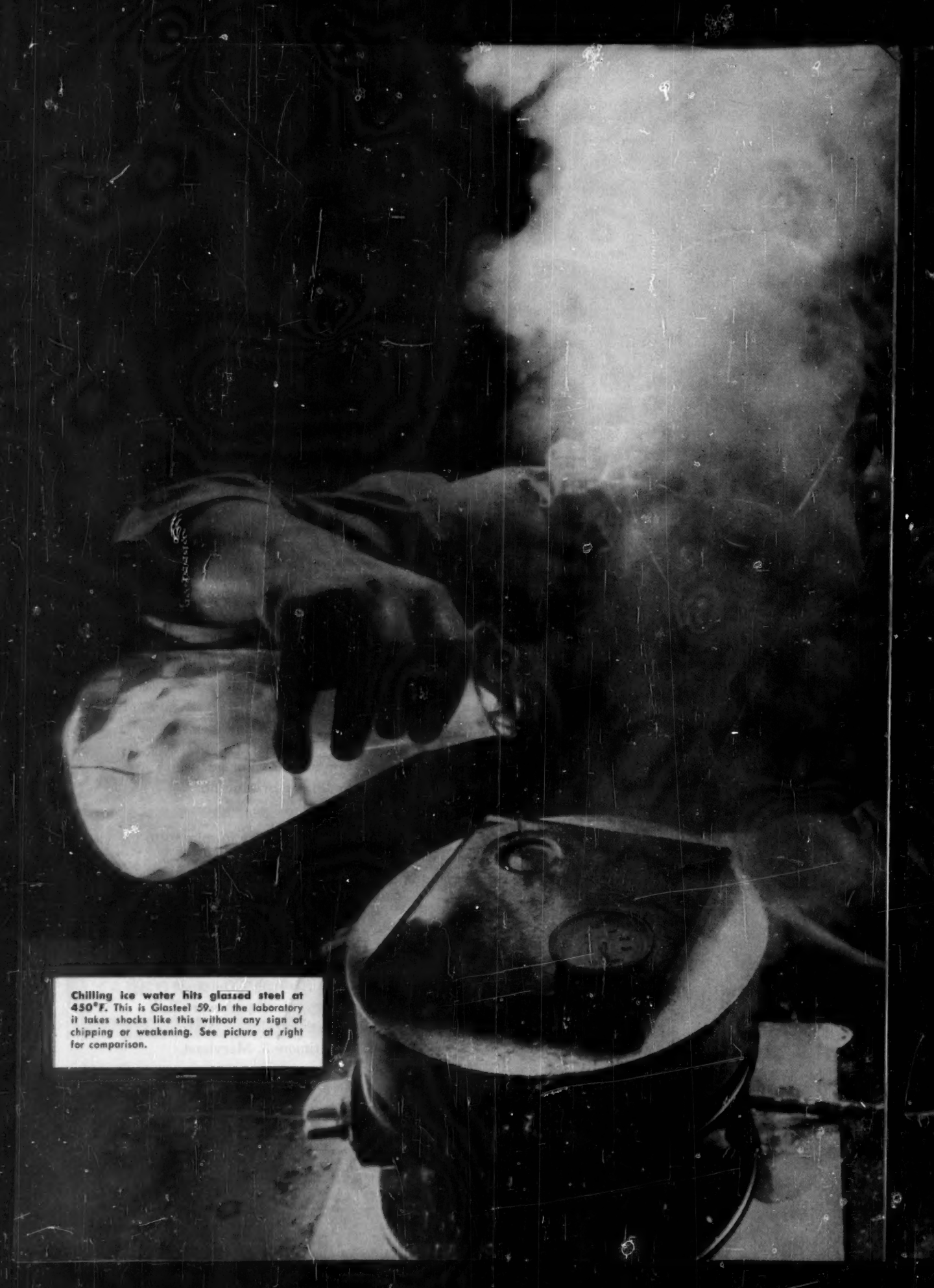
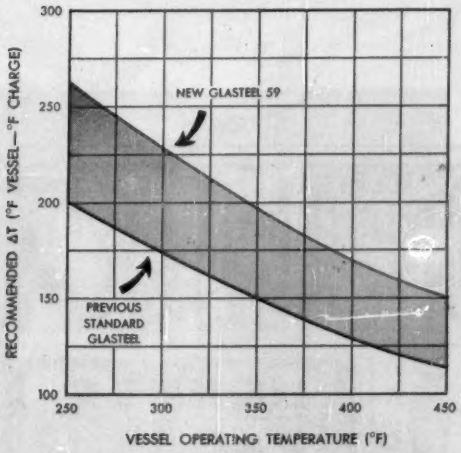


Chilling ice water hits glassed steel at 450°F. This is Glasteel 59. In the laboratory it takes shocks like this without any sign of chipping or weakening. See picture at right for comparison.

THERMAL SHOCKING NEWS

about new Pfaudler Glasteel 59*

If you have ever crazed a glassed-steel vessel from thermal shock . . . if for any reason your processing is less economical than it might be from risk of thermal shock . . . take a close look at the blue line on this graph.



That blue line marks the new high in thermal shock resistance set by Pfaudler Glasteel 59.

Just a quick glance at the graph shows that Glasteel 59 gives you 30% more thermal shock resistance than the best previous glassed steel. It provides added insurance against thermal shock damage where unexpected or unavoidable high-temperature differentials are encountered.

At your normal vessel operating temperature, the safe ΔT for Glasteel 59 is 260° F. It used to be 200° F. At the peak operating temperature of 450° F., safe ΔT is now 150° F. It used to be 115° F. All these figures contain a very generous safety factor of *three*, based on carefully controlled laboratory experiments.

Lasts longer. Glasteel 59 will give you much longer service life from your vessels.

20% more abrasion resistance. Glasteel 59 gives you a full 20% more abrasion resistance than previous glassed steels.

Top acid resistance. Now you can work any acid, except hydrofluoric, up to 325° F. without excessive corrosion.

Under certain conditions you can even raise an acid to 450° F. without damage.

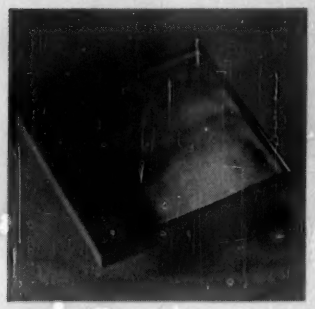
Very good alkali resistance. Glasteel 59 has twice as much resistance to alkalies as your hard glass labware.

Lapped nozzle faces. The unique microstructure of Glasteel 59, which is the reason for improved thermal shock resistance, also allows lapping of nozzle faces on vessels above 500 gallons—smaller vessels on request. You get better gasket seating and more service life.

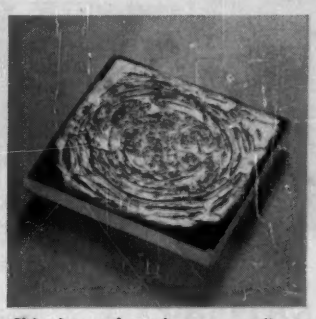
Plug-free vessels. In many of the small and intermediate sizes we offer plug-free vessels with Glasteel 59. On all other vessels there are fewer plugs than before.

No additional cost for Glasteel 59 on all Pfaudler standard equipment.

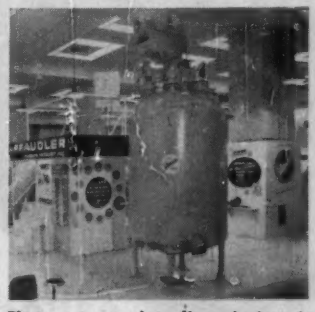
Send for new Buyer's Guide. The new 1959 Pfaudler Buyer's Guide shows all the glassed-steel equipment available with Glasteel 59. Write for a copy. Just ask for Bulletin 968.



No thermal damage whatsoever was suffered by Glasteel 59, shown at left. All Pfaudler vessels are now available with this new construction.



Chipping and crazing appear all over this plate of the best previous glassed steel subjected to the same shock as the Glasteel 59 plate.



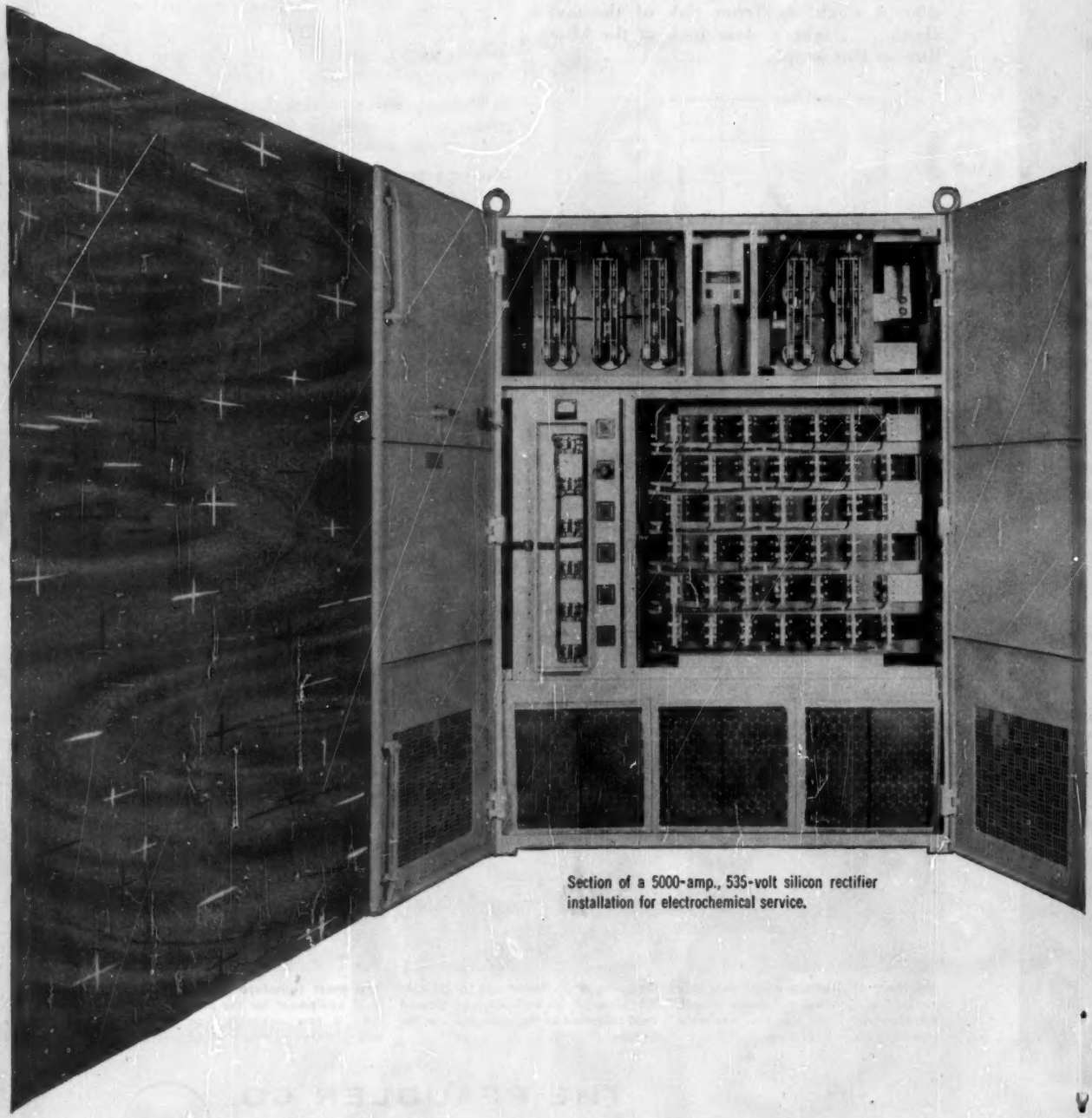
The most complete line of glassed-steel equipment for the process industries is now available from Pfaudler with the new Glasteel 59 construction.

THE PFAUDLER CO.
a division of **PFAUDLER PERMUTIT INC.**
Dept. CE-78, Rochester 3, N. Y.

*Patent Pending

Westinghouse Silicon Rectifiers...

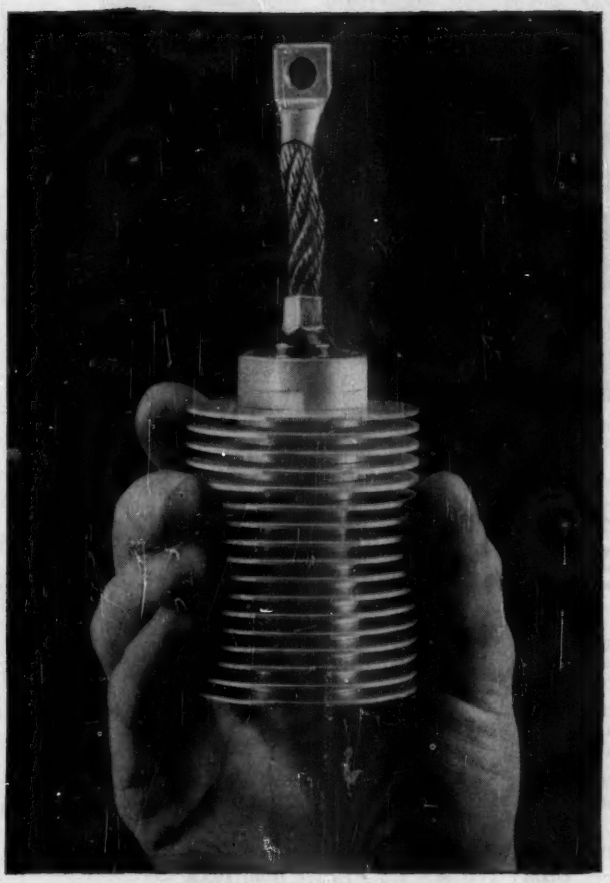
higher efficiency, simpler construction



Section of a 5000-amp., 535-volt silicon rectifier installation for electrochemical service.

for medium and low voltage

electrochemical processing economy



Helping you curb the high cost of processing is the job of these new air-cooled, high-efficiency Westinghouse silicon rectifiers. Cost of power — as reflected in final product costs — is now made lower than ever before.

Low cost . . . advanced circuitry eliminates complicated excitation equipment and simplifies construction.

High efficiency . . . approximately 95% overall, for low and medium voltage applications.

Long life . . . no detectable aging of silicon cells has occurred even after many years of use.

Ease of installation . . . units are completely factory-assembled. You need only make a-c and d-c connections.

No costly outages . . . indicating equipment will detect cell failure. Drawout construction makes replacement quick and easy without dropping load.

For full information on Westinghouse silicon rectifiers for electrochemical applications, call your Westinghouse representative or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-15008

YOU CAN BE SURE...IF IT'S **Westinghouse** (W)

Each of these mixers weighs over four tons, yet they are so perfectly balanced they stand alone on their supporting blocks. Side support is not required. This means minimum stress on tank top flanged nozzles which support the mixers.

EXPANDED ESSO ALKYLATION UNIT TO USE

42 PHILADELPHIA MIXERS

Forty-two vertical Philadelphia Mixers like the ones shown are being installed at the Baton Rouge Refinery of Esso Standard Oil Company. They are part of an alkylation process in which concentrated sulfuric acid serves as a catalyst to unite light olefins and isobutane to produce high octane gasoline blend stock. Installed in the various reaction zones of the reactors, they insure optimum contact of reactants.

These units are equipped with a shut-off device below the mechanical seal which permits seals to be changed with reactor vessels held at full pressure. This can be done simply and quickly, and requires *no external lifting equipment.*

For this, or any other fluid mixing job, Philadelphia Mixers offer many important design advantages.

- Extra large, heavy duty bearings throughout permit every drive component to be designed to required degree of stiffness. The strength and rigidity of drive assemblies keep gearing effectively isolated from unbalanced output shaft loads which might cause damage.
- Extremely heavy output shafting keeps shaft deflection to an absolute minimum, even under heavy unbalanced mixing loads.
- Extra long output shaft bearing span insures precision shaft operation and minimum runout in the seal area.
- All gearing is induction hardened and ground or crown shaved for long, quiet, trouble free life.
- Quick change gear sets are available from stock to furnish 14 standard AGMA output speeds.

To select the exact mixer for your process needs, write for Catalog A-27. It contains all the information needed to make a catalog selection of a complete mixer assembly.

PHILADELPHIA GEAR CORPORATION
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philadelphia mixers

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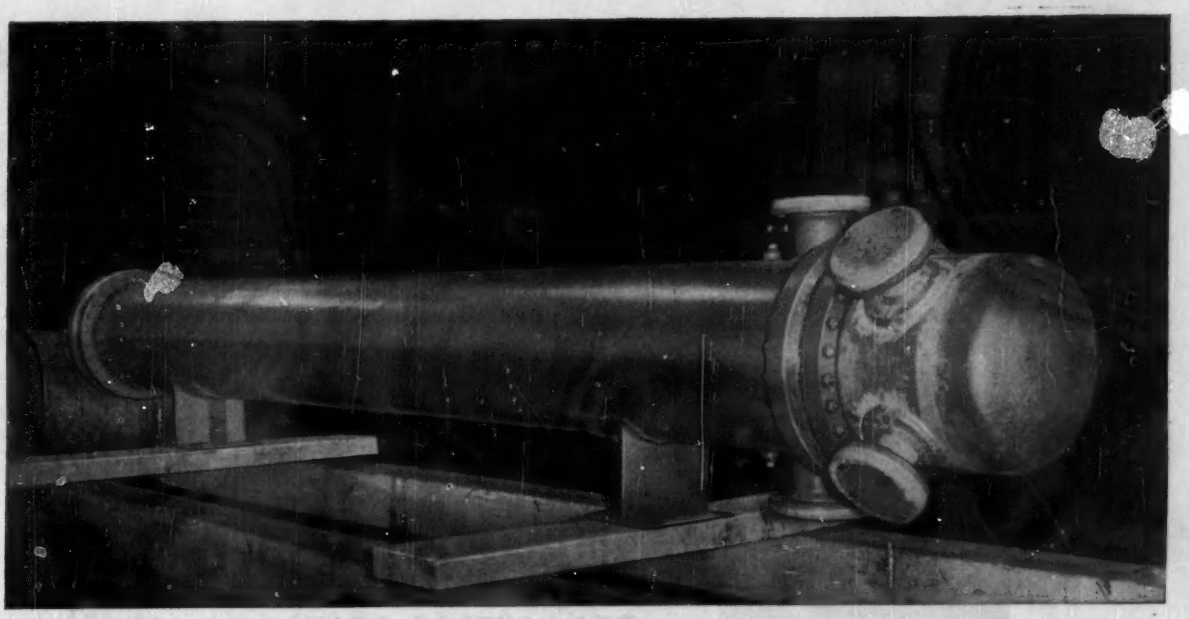
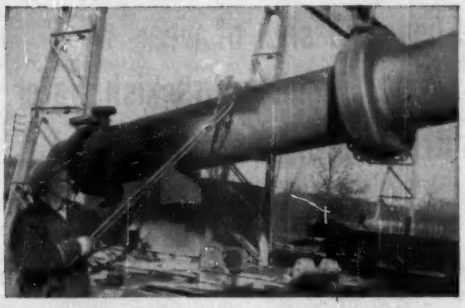
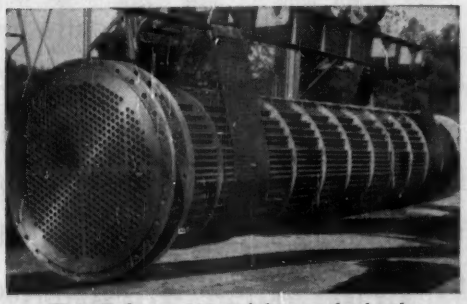


Aluminum translated by Downingtown... metallurgically speaking



Putting the finishing touch on another heat exchanger unit built by Downingtown.



We rolled type 329 stainless steel tubes into types 316 and 304 tube sheets in making this stainless steel replacement bundle.

The special problems of aluminum welding and fabrication are another metallurgical "language" that has been expertly mastered at Downingtown. In this fixed-tube sheet heat exchanger unit, aluminum heads, tubes and tube sheets have been combined with a carbon steel shell to meet specific service conditions.

When heat transfer specifications call for aluminum...or aluminum bronze, nickel, copper, stainless steel, or almost any clad or alloy...you'll find the metallurgical idiosyncrasies are well understood at Downingtown. Send for our informative booklet on heat exchanger design.

SPECIFICATIONS OF THE UNIT

Materials: Aluminum Tube Side and Carbon Steel Shell
Tubes: 192 Alclad Tubes, ¾" O.D. x 16 ga. x 14'0" L
Shell Diameter: 18"
Over-All Length: 16' 1"
Design Pressure: Shell Side, 100 psi—Tube Side, 200 psi
Test Pressure: Shell Side, 150 psi—Tube Side, 300 psi
Design Temperature: Shell Side, 250° F.—Tube Side, 350° F.
Code Stamped: Inspected by Purchaser and Hartford

Downingtown Iron Works, Inc.

140 Wallace Ave., Downingtown, Pennsylvania

division of PRESSED STEEL TANK COMPANY Milwaukee

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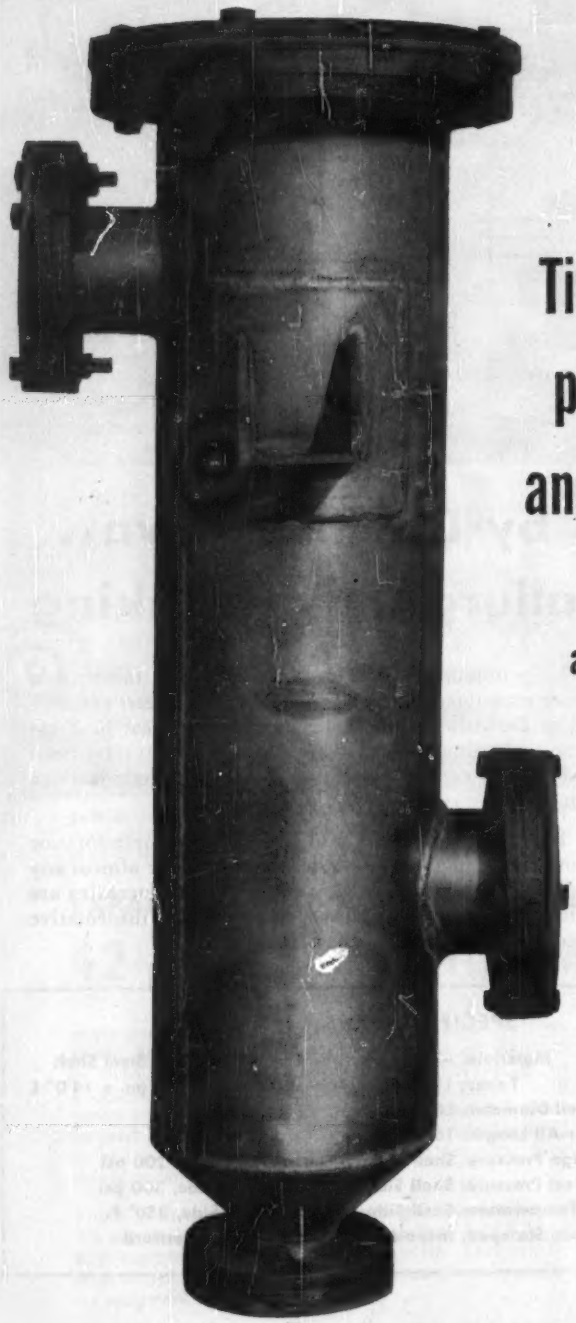
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

TITANIUM—available now for long service



Titanium jet after-condenser proves immune to chloride and stress-corrosion cracking

Shows no sign of wear after 52 months handling brackish water, nitric and organic acids!

An environment of raw brackish water, nitric and organic acids cut the service life of a jet after-condenser to 6 months because of stress-corrosion cracking. Fabricated with a stainless alloy, replacement cost and downtime were costly. A *titanium* jet after-condenser was then installed. Result: no breakdown in 52 months, no sign of corrosion...and a saving of more than $3,800 in replacement costs!

• Brackish water containing nitric and organic acids had no measurable effect on this titanium jet after-condenser.

life . . . corrosion resistance . . . economy in use

Proven economies

Titanium is actually the *least expensive* metal you can use under many corrosive influences. It withstands conditions that reduce the service life of ordinary and high-alloy metals . . . cuts down-time and replacements.

Titanium offers the economy of long, trouble-free service when exposed to such corrosive environments as:

Salt Water
Marine Atmospheres
Nitric Acid
Wet Chlorine
Chlorinated Organic Compounds
Most Inorganic Chloride Solutions
Molten Sulfur
Chromic Acid
Aqua Regia
Hypochlorites & Chlorine Dioxide

TITANIUM—available today

Titanium is now readily available for non-defense applications. Standard parts of titanium are already solving severe corrosion problems in the chemical processing, food, pulp, paper and allied industries.

In your process-development work, take advantage of the corrosion and cavitation resistance, light weight and high strength of titanium . . . important considerations for continuous flow, high temperature and pressure processes.

As a manufacturer and pioneer producer of titanium sponge, Du Pont has been working with leading mill-product producers and process-equipment manufacturers on the commercial development of titanium. This broad experience can be applied to *your* corrosion problems. Just get in touch with Du Pont for further information.

Be sure to mail the coupon below for a new informative booklet about titanium—its properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Titanium Market Development Section, Wilmington 98, Delaware. (This offer is limited to the United States and Canada.)

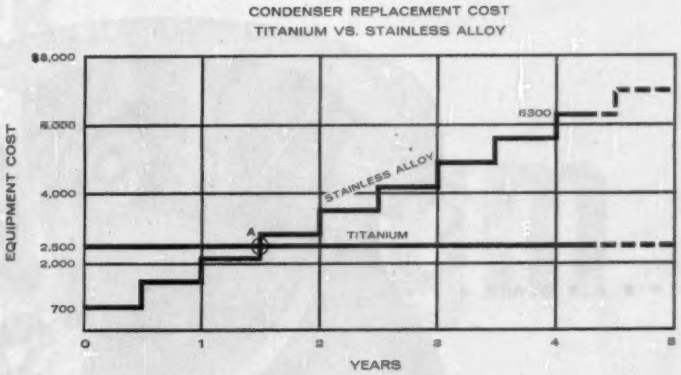
PIGMENTS DEPARTMENT

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Pioneer producer of

TITANIUM SPONGE



EQUIPMENT COST of a titanium jet after-condenser is compared with a stainless alloy condenser handling highly brackish water containing nitric and organic acids. The stainless alloy condenser cost $700, failed after 6 months . . . titanium unit cost $2,500, has shown no sign of corrosion after 52 months of continuous operation. The $1,800 difference in cost was absorbed in 1½ years (Point A). Titanium has saved $3,800 in replacement costs . . . condenser maintains trouble-free performance.

NOW READILY AVAILABLE, titanium parts and fittings like this 4" gate valve, chemical pump and centrifuge can be made to your order by process-equipment fabricators.

E. I. du Pont de Nemours & Co. (Inc.)
Titanium CE-7, MDE-8, Wilmington 98, Del.

Please send additional information on properties and uses of titanium. I'm interested in titanium for these applications:

_____

_____

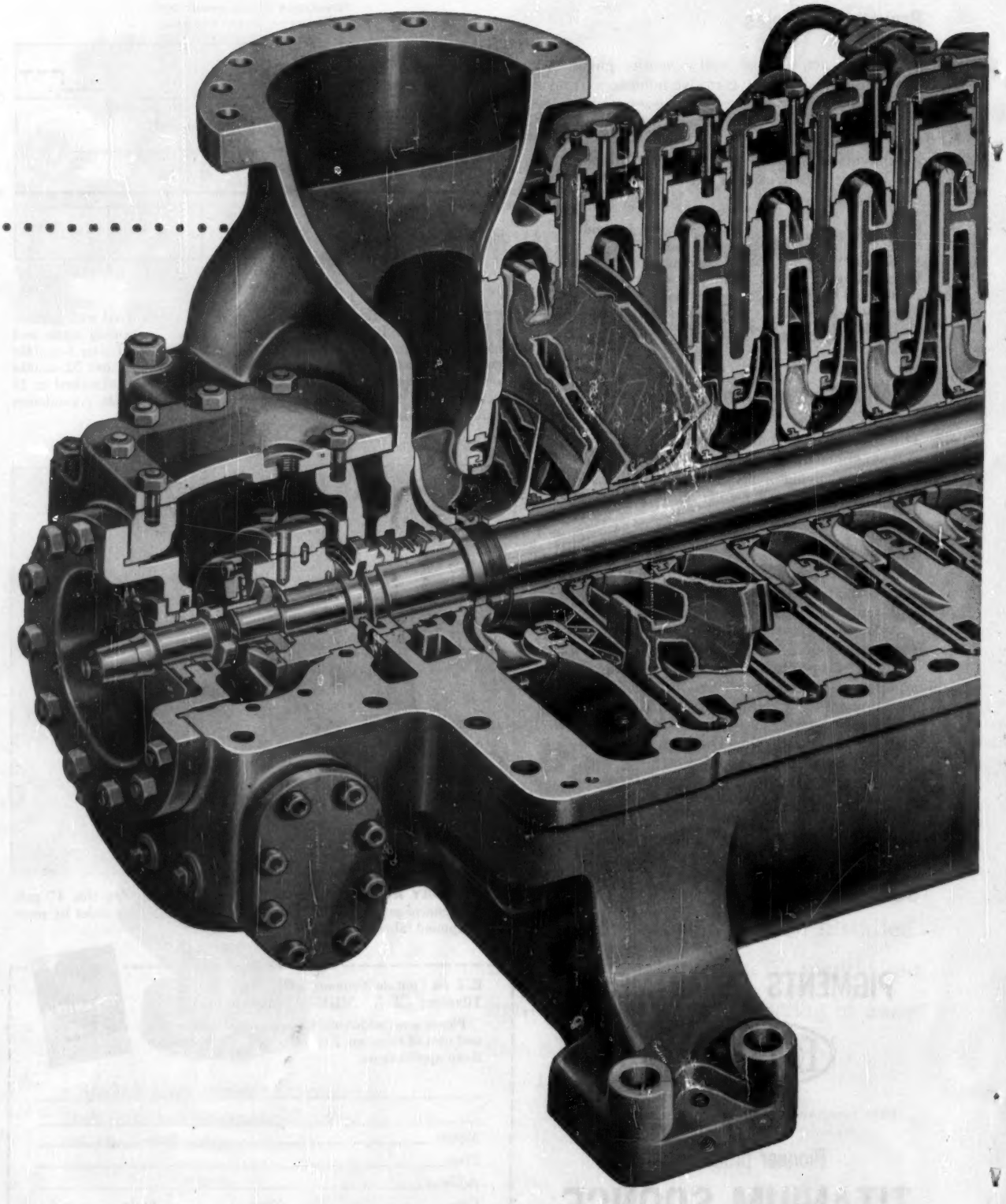
Name _____ *Title* _____

Firm _____

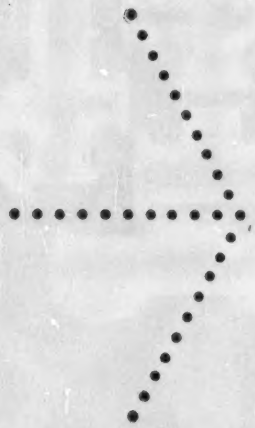
Address _____

City _____ *Zone* _____ *State* _____

(Offer limited to the United States and Canada.)



CLARK



Diaphragm Cooling

- **Minimizes polymer formation**
- **Slashes horsepower requirements**
- **Greater safety handling hazardous gases**
- **Reduces capital investment**

Clark double-wall diaphragm cooling is the simplest, safest, and most effective way to intercool a multi-stage centrifugal compressor. Furthermore, polymer formation is minimized in the compressing of unsaturated hydrocarbon gases by the use of diaphragm cooling. It is a simple, economical method of maintaining gas temperature at the desired level in the capacity range of 1,000-30,000 CFM.

Power savings are an additional benefit of diaphragm cooling. The savings range from 20% on 15 molecular weight vacuum gas compressing applications to 5% for 110 psig. air compressors. Reduced installation and operating costs result.

Minimum capital investment is realized another way. Applications involving high compression ratios such as gas recovery and 120 psig. or less air compressors can be handled in a single case.

Diaphragm cooling also assures maximum safety when compressing oxygen, acetylene, and other difficult gases. Internal surfaces are always cool. Danger from potential hot spots is highly remote.

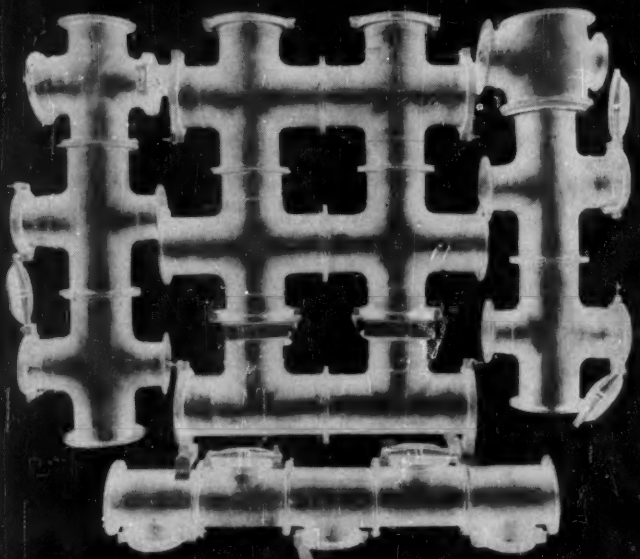
Clark builds a complete line of multi-stage centrifugal compressors and in many instances a gas turbine to drive them. Your nearest Clark representative has all the facts.

CLARK BROS. CO. OLEAN, N. Y.
One of the Dresser Industries
Offices in Principal Cities Throughout the World

CLARK

Centrifugal Compressors
Gas Turbines

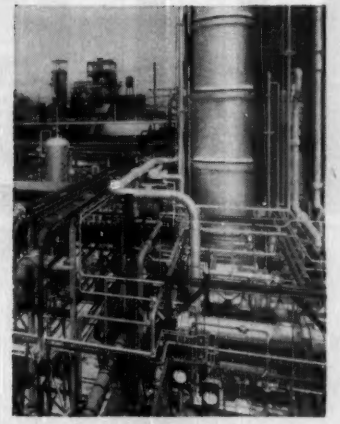
Specialized



Another Service

of Vulcan-Cincinnati

Pipe Fabrication...



The fabrication of complex piping arrangements—which often exceed the capabilities of ordinary pipe shops—is a specialized activity at Vulcan. Here all work is supervised by master metalsmiths who are intimately familiar with the problems of fabricating stainless, copper and many other metals and alloys.

Vulcan's background of chemical industry experience enables us to accurately interpret specifications and economically fabricate to the close tolerances required in present-day chemical applications. This experience also extends to on-site supervision and training of local personnel in the proper techniques of field fabrication and assembly.

Our shops are completely equipped with facilities for pickling, passivating and testing. And all work is performed according to ASME, API-ASME and ASA codes. When your needs call for manifolds, jacketed or lined piping—even applications calling for unusual materials like Saran and Karbate—rely on the experience of Vulcan-Cincinnati.

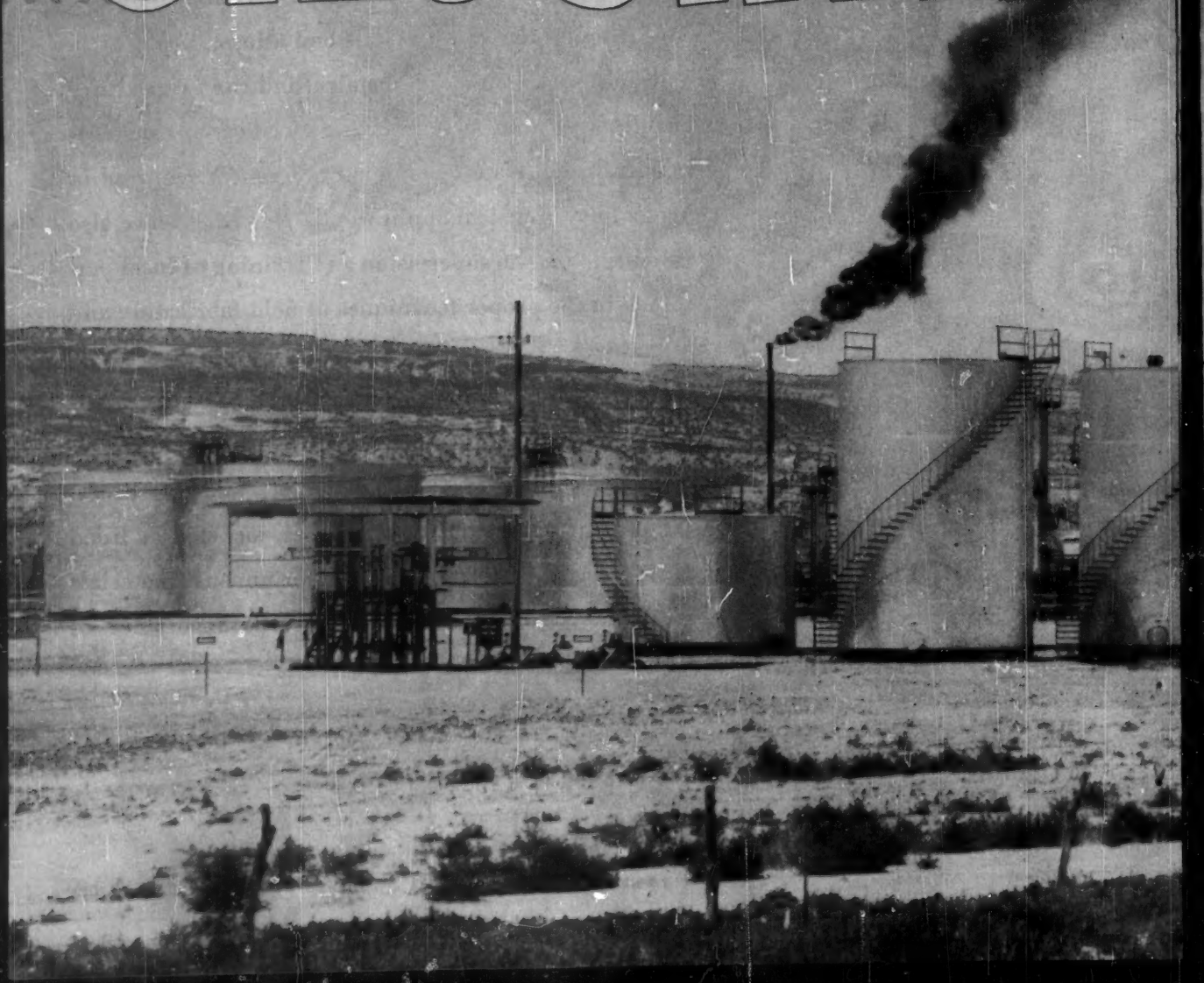
VULCAN-Cincinnati, Inc.

VUL-613

Engineers and Constructors • 120 Sycamore Street • Cincinnati 2, Ohio

from "nature's freak"
to high octane bonanza . . .

GILSONITE



COKE DRUMS and STORAGE TANKS serve First Solid Hydrocarbon Refinery

One of nature's "freaks", Gilsonite® ore is an asphaltite—a petroleum-like substance which somehow failed to liquify. This long-known but commercially unproved mineral remained virtually dormant until present day technology opened up a new Gilsonite "era".

Now, American Gilsonite Company has opened the first plant to economically produce gasoline from a raw material other than crude oil . . . their Gilsonite refinery near Grand Junction, Colorado. Here, this unique plant transforms the solid hydrocarbon into high-octane gasoline and high-purity metallurgical coke.

Playing an important part in the over-all processing operations for American Gilsonite is a total of seventeen CB&I storage tanks of various types, as well as two large coke drums furnished through the Foster Wheeler Corporation.

An unusual installation, perhaps . . . but a good example of the way in which CB&I-built tanks and steel platework serve *all* phases of the petroleum industry.

Write our nearest office for details—*ask for the new CB&I FIELD SERVICES BULLETIN.*

This panoramic view of the modern new American Gilsonite Company plant outside Grand Junction, Colorado, shows some of the CB&I tanks and coke drums for storage and processing service. Included are 8 Horton® Cone Roof Tanks; 7 Horton Double-Deck Floating Roof Tanks; 2 Hemispheroids®; and two 18-ft. diam. by 62-ft. Coke Drums. American Gilsonite Company is an affiliate of Standard Oil Company of California and Barber Oil Company of New York.

P64SCB

Chicago Bridge & Iron Company

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New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
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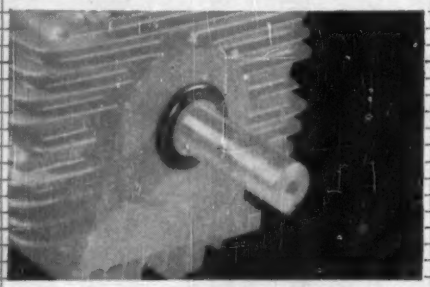
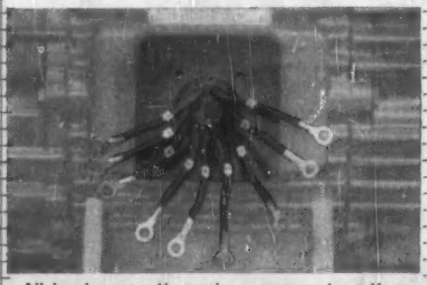
Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas; Chicago Bridge Limited, London; Sociedade Chibridge de Construcoes Ltda., Rio de Janeiro.

ELLIOTT C-W SEALEDPOWER

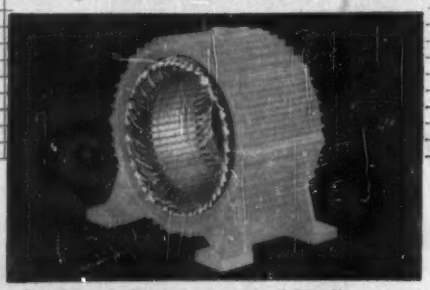
Sturdy external fan has a split hub both keyed to the shaft. No chance of slippage or loosening.



A slinger on the motor shaft effectively guards against the entrance of moisture and foreign material. Slinger is recessed into the bearing bracket to provide a long, labyrinth-type seal.



All leads pass through a grommet as they are brought out of the motor frame. When conduit box is mounted in position, the grommet is tightly compressed, providing a snug seal at this vulnerable area.



Precision-built stators are individually surge tested, and impregnated with siliconized varnish, for improved heat stability and heat resistance.

. . . designed for the dirty jobs

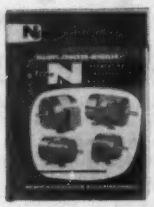
Elliott C-W Sealedpower motors can safely be installed outdoors, or in dusty, moist and corrosive atmospheres. Internal parts are thoroughly protected from the environment. Many users have standardized on this type of motor for all applications because they find that the total cost—first cost plus maintenance—is less for totally-enclosed motors than for conventional enclosures!

This popular, dependable group of motors is part of the Elliott C-W line, which includes also standard Dripproof-protected and Explosion-proof designs.

The original C-W fin-cooled, self-cleaning design which provides more cooling area—no internal passages to clog.

ELLIOTT Company

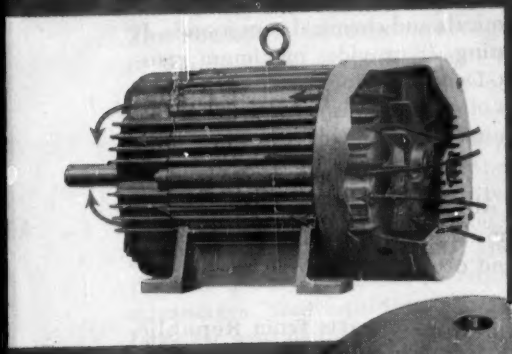
CROCKER-WHEELER PLANT, Jeannette, Pennsylvania



Write for Bulletin PB 6000-6, which describes in detail the features which make Elliott C-W motors outstanding.

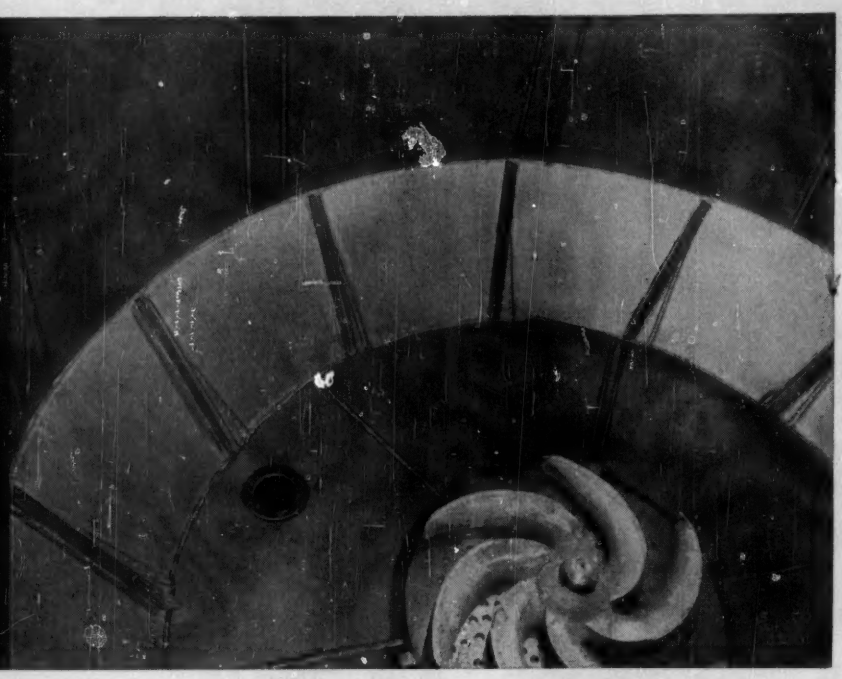
we-2

ENCLOSED MOTORS



STAINLESS STEEL SOLVES 4 PROBLEMS

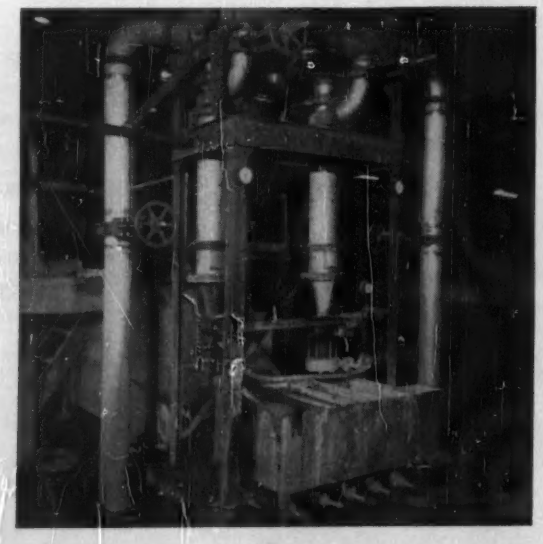
Provides "Bonus Benefits" for the Fox Paper Company



Problems 1 & 2: Heat and corrosion in this pulper used to defiber wood pulp and waste paper at The Fox Paper Company, Lockland, Ohio.

Solution: Line the sides of the tub with Republic ENDURO Stainless Steel and use a rotor cast from stainless steel.

The reason: No other commercial construction material matches stainless steel for its combination of qualities and physical properties so essential to the mechanical and chemical stages of processing. Stainless steel maintains its great strength and toughness at blistering heat. It resists scaling at high temperatures. Possesses high creep strength. Stainless is inert to most chemicals and chemical compounds. It is non-contaminating. It provides maximum resistance to corrosion. Danger of stock loss due to inclusion of the oxides of corrosion or other contaminating matter is eliminated. These are "bonus benefits".



Problem 3: Abrasion in this paper stock cleaning equipment used to remove particles of sand, grit, metal, and other objectionable material.

Solution: Fabricate all parts from Republic ENDURO Stainless that would come in contact with the stock and water as it goes through these units with a cyclonic action based on a pressure drop principle.

The reason: Stainless steel provides outstanding resistance to abrasion. A bonus is obtained through the exceptionally high strength-to-weight ratio of ENDURO. It doesn't buckle or fail under pressure, even when used in thinner, bulk-saving sections. Another bonus is cleanability. A simple flushing with water or diluted acid solution brings ENDURO back to sparkling cleanliness.

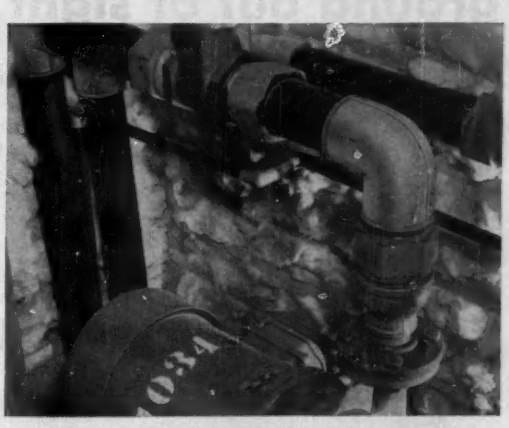
These examples of the advantages of stainless steel are brought to you by Republic Steel in behalf of the stainless steel equipment manufacturers and the Republic Stainless Steel distributors—your local steel service centers.

Problem 4: Wear as fiber passes between sets of knives mounted on the plug and shell of this Jordan Engine.

Solution: Use Republic ENDURO Stainless Steel for this application.

The reason: The inherent strength and toughness of stainless steel combined with its smooth, hard surface offers maximum resistance to wear. Additionally, stainless holds a good edge. Takes stress and vibration in stride as the plug revolves inside the shell. The Fox Paper Company, through an extensive use of ENDURO Stainless Steel, is also benefiting from faster production, elimination of spoilage, reduced maintenance, lower costs, higher product quality. You can be enjoying these same advantages. Your equipment supplier has all the facts. Or send us the coupon for more information.

REPUBLIC ELECTRUNITE "Dekoron-Coated" Electrical Metallic Tubing solves conduit problem at Charmin Paper Products Company. Acid fumes and moisture combined to corrode standard heavy-wall conduit so badly it had to be renewed every six months. Charmin replaced the conduit with "Dekoron-Coated" E. M. T. seven years ago. It has outlasted standard conduit ten to one. A polyethylene coating encases strong, lightweight ELECTRUNITE® in an end-to-end armor that is impervious to fumes and moisture. Also available in hot galvanized rigid steel conduit. Mail coupon for complete facts.



REPUBLIC SRK PLASTIC PIPE EXTENDS LIFE of piping installations by providing excellent corrosion-resistance. Republic SRK (Semi-Rigid Kralastic) is satisfactory for Kraft, Black, Green, White, and Sulfite Liquors—as well as Chloride Bleach and Alum. SRK requires no maintenance. Replacement costs due to corrosion are eliminated. Its extreme toughness shrugs off mechanical abuse. Republic SRK is lightweight, easy to carry . . . easy to install. Available in sizes ½" through 6" in a range of working pressures. Send coupon for complete details.

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World's Widest Range of Standard Steels and Steel Products

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Please send more information on:
☐ ENDURO® Stainless Steel ☐ SRK Plastic Pipe
☐ ELECTRUNITE "Dekoron®-Coated" E. M. T.

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Quiet Genie At Work...

F-M Submersible Pumps work silently below ground out of sight

Working silently, deep in the earth, F-M submersible pumps supply millions of gallons of water each day for industries, municipalities, and communities throughout the world. Permitting well location anywhere a well can be drilled, F-M submersible pumps do away with unsightly installations and costly pump housing.

Submerged below water level, these pumps need no line shafts, packing boxes or lubrication equipment. Wearing parts... chief source of maintenance troubles...are reduced to a minimum.

Water Lubricated, Water Cooled... Built to Last by Fairbanks-Morse

The Fairbanks-Morse motor at the heart of the submersible pump has a lifetime Copperspun rotor cooled and lubricated by water. In combination with F-M—Pomona pump bowls, these wet stator motors give unbeatable pumping performance over a wide range of volume, depth and pressure requirements.

For full facts about community service or industrial use, see your F-M Sales Engineer or write for Bulletin 6910 today:
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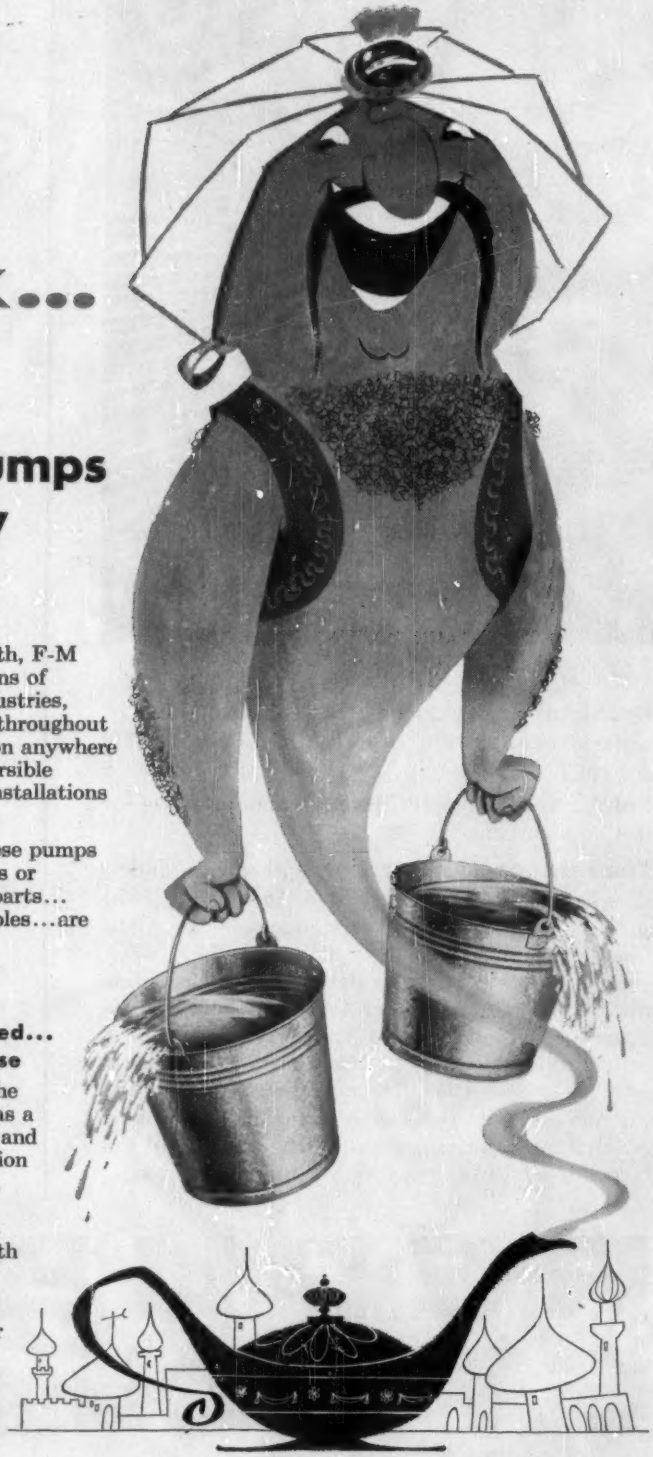
600 South Michigan Ave.,
Chicago 5, Ill.



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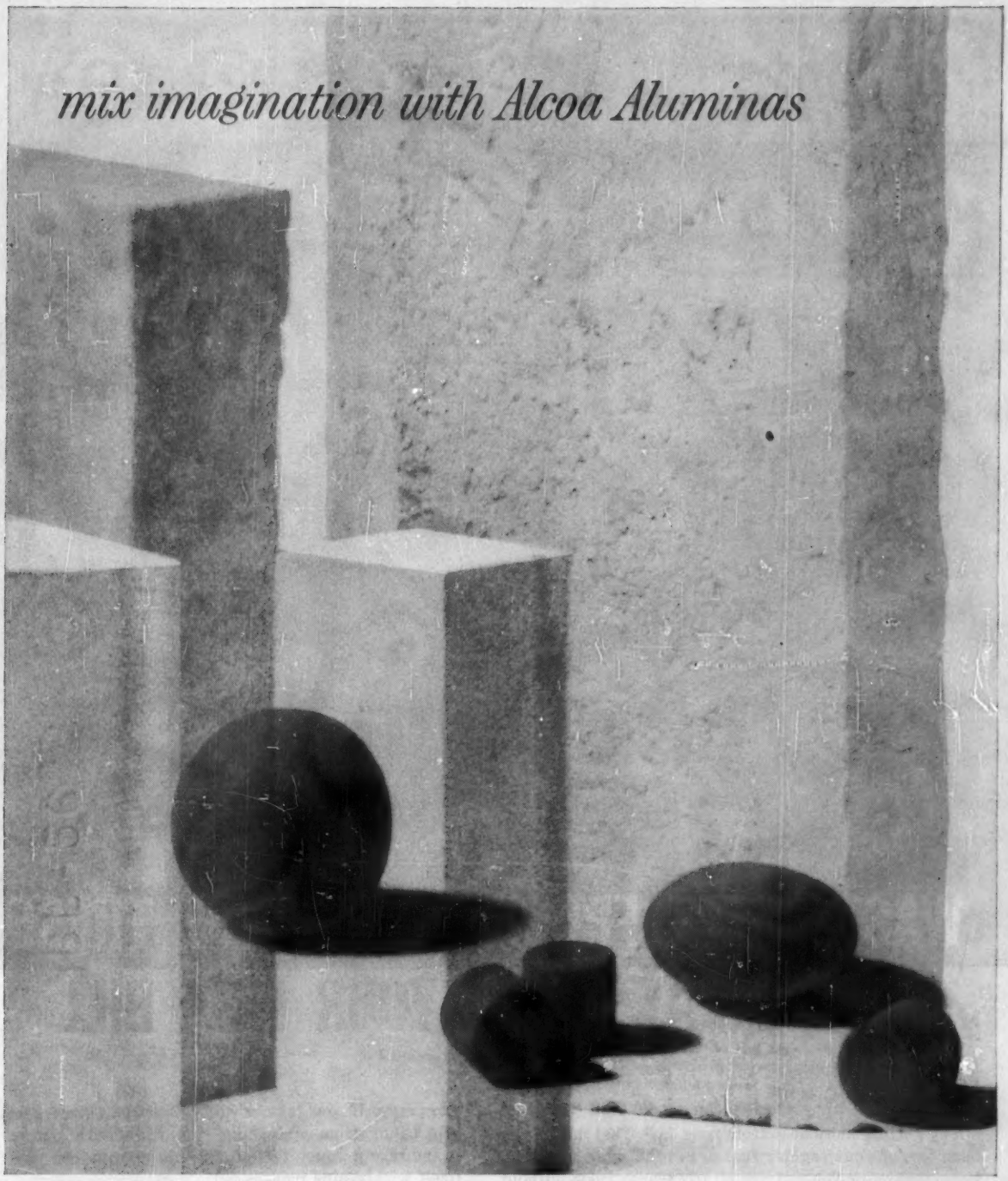
a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS



to beef up these backbones of industry: Few industries could prosper without high performance ceramic refractories, mill liners and grinding media. They are the backbones of industry . . . and they will serve best, serve longest when imaginative engineering puts Alcoa® Aluminas in their composition. These pure aluminum oxides increase refractoriness in direct proportion to the amount used . . . they increase stability and strength under load at high temperatures . . . improve resistance to thermal and structural spalling or deformation . . . minimize corrosion and erosion. Small wonder that users and makers of refractory shapes and castables, ceramic grinding media and mill liners have found it pays to mix imagination and engineering with Alcoa Aluminas . . . for top performance at reasonable cost.

Alcoa does not manufacture refractories, mill liners or grinding media. We do supply aluminas to makers of the best of these products. For their names, write ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 702-G Alcoa Building, Pittsburgh 19, Pennsylvania.

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For finer products . . . let Alcoa add new dimension to your creative thinking!

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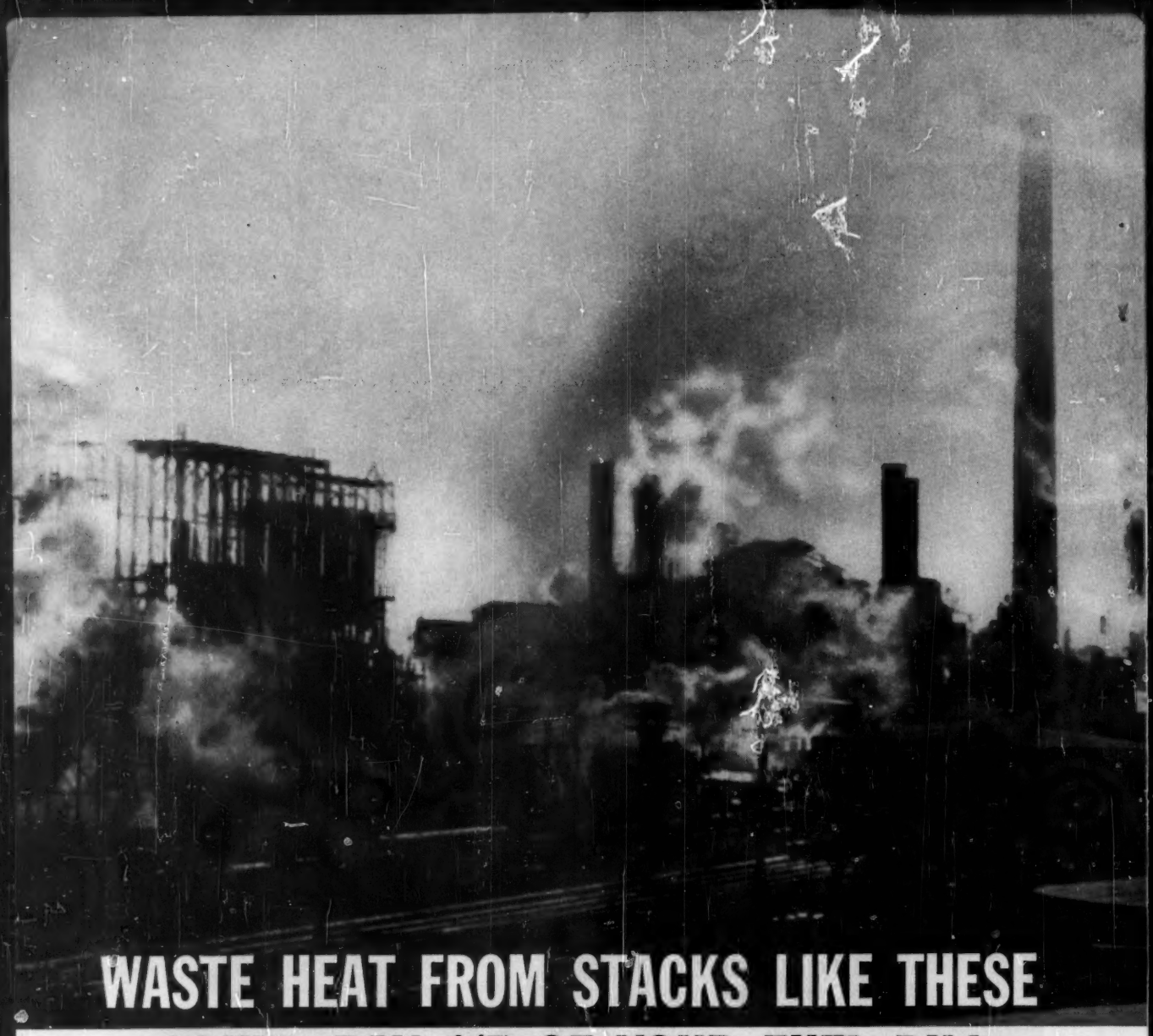
Exciting Adventure
ALTERNATE MONDAY EVENINGS



WASTE HEAT FROM STACKS LIKE THESE COULD PAY 1/5 OF YOUR FUEL BILL

A Ljungstrom® air preheater can cut 20% off your fuel bill by getting more heat from your fuel. That means you burn less of your regular fuel to get the same operating temperature, or you can switch to cheaper fuels without affecting product quality. Either way, every barrel of output can cost 20% less in fuel.

A Ljungstrom air preheater gets more productive heat from any fuel by boosting the temperature of the combustion air – sometimes as much as 1000F. Fuel burns more completely in preheated combustion air, and leaves less slag and deposit behind, so the fuel-burning equipment stays efficient longer.

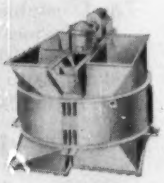
How fast is "WRITE OFF"?

What you save on fuel can pay for the Ljungstrom in two years. If you take advantage of the extra capacity of a Ljungstrom-equipped system to increase output or to improve product quality, the Ljungstrom can pay for itself within nine months.

Write today for your copy of a factual article by Mr. O. F. Campbell of Sinclair Refining Company, describing one company's fuel savings with a Ljungstrom air preheater. Call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

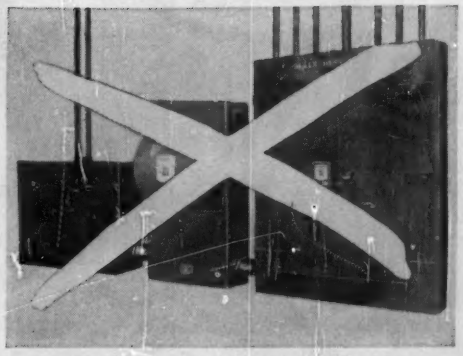


The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

THIS NEW *POWER-STYLE* SWITCHBOARD

TAKES LESS SPACE and COSTS LESS, TOO!

above • **the modern way.** C/T compartment and six distribution branches are combined in a single cubicle with all inter-connections bussed. Because installation time and costs are cut so drastically, this new way actually costs less than the old!

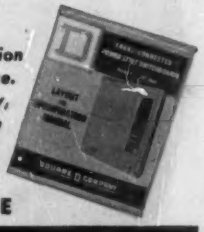


above • the old way of installing service entrance—a C/T cabinet, a large safety switch and a panel board or a gang of smaller safety switches were hung on a wall and connected by a complicated arrangement of wireway or conduit and cable. Expensive, space-consuming and unsightly.

POWER-STYLE FEATURES

- Only 14 inches deep and 30″ or 36″ wide... saves valuable space!
- Complete front accessibility—connect all circuits from the front!
- Standardized C/T compartment meets Edison Electric Institute and Public Utilities' specifications.
- Service sections are also available with a main switch or main breaker...arranged for either hot or cold sequence.

Write for Layout and Specification Manual...a valuable source of reference. Address Square D Company, 6060 Rivard Street, Detroit 11, Michigan



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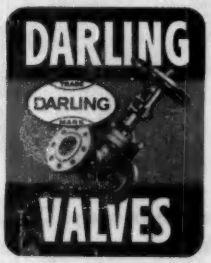
SQUARE D COMPANY

ALUMINUM GATE VALVES

by Darling

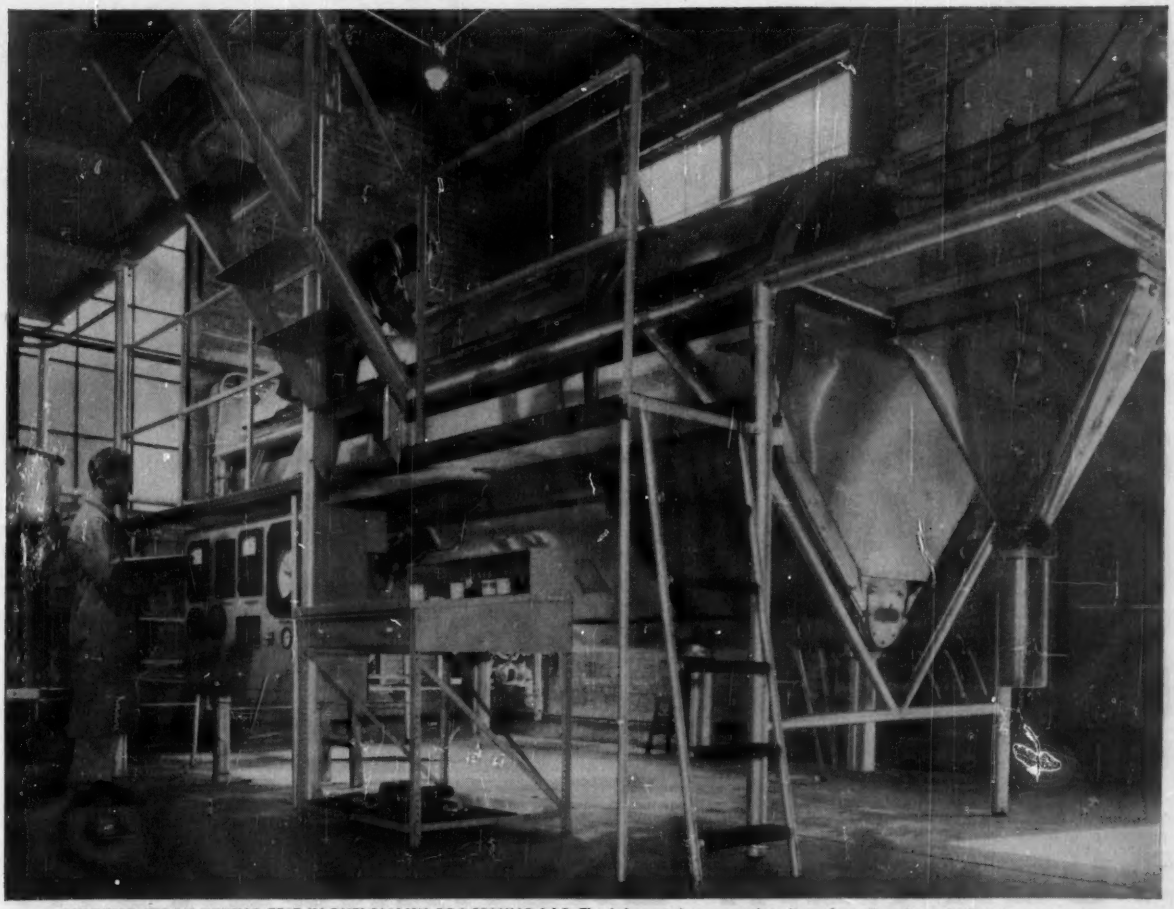
Darling gate valves of aluminum alloy offer all of the unique, extended-life features inherent with the Darling fully revolving double disc, parallel seat principle... for performance that assures unmatched economy... and freedom from leakage, trouble and downtime!

These Darling aluminum alloy valves are now available in ½" through 24" sizes. Write for full details, specifying your particular service requirements.



DARLING VALVE & MANUFACTURING CO.

WILLIAMSPORT 3, PA.



RUNNING SPRAY DRYING TEST IN BUFLOVAK'S PROCESSING LAB. The lab contains a complete line of small scale and pilot size processing equipment for investigating drying, evaporation, extraction, impregnation, crystallization, and other processes. Here you can test a few beakers of material or run tank car quantities on a full time production scale.

Buflovak Spray Dryers—new horizontal high velocity design for instant drying... improved products...lower operating costs

Whether it's food or chemicals, Buflovak flash drying gives products new, more marketable characteristics.

Buflovak Horizontal Spray Dryers convert a liquid to a dry product instantaneously. Short exposure to heat helps to retain all the desirable product characteristics. Particle size and shape can be selected and controlled. The finished product is continuously removed and discharged from one point.

Compactly designed, these dryers require little headroom, keep initial and operating costs low. Complete accessibility makes between-batch cleaning easy and economical. Buflovak Spray Dryers offer a choice of high efficiency powder collecting systems best suited to your product.

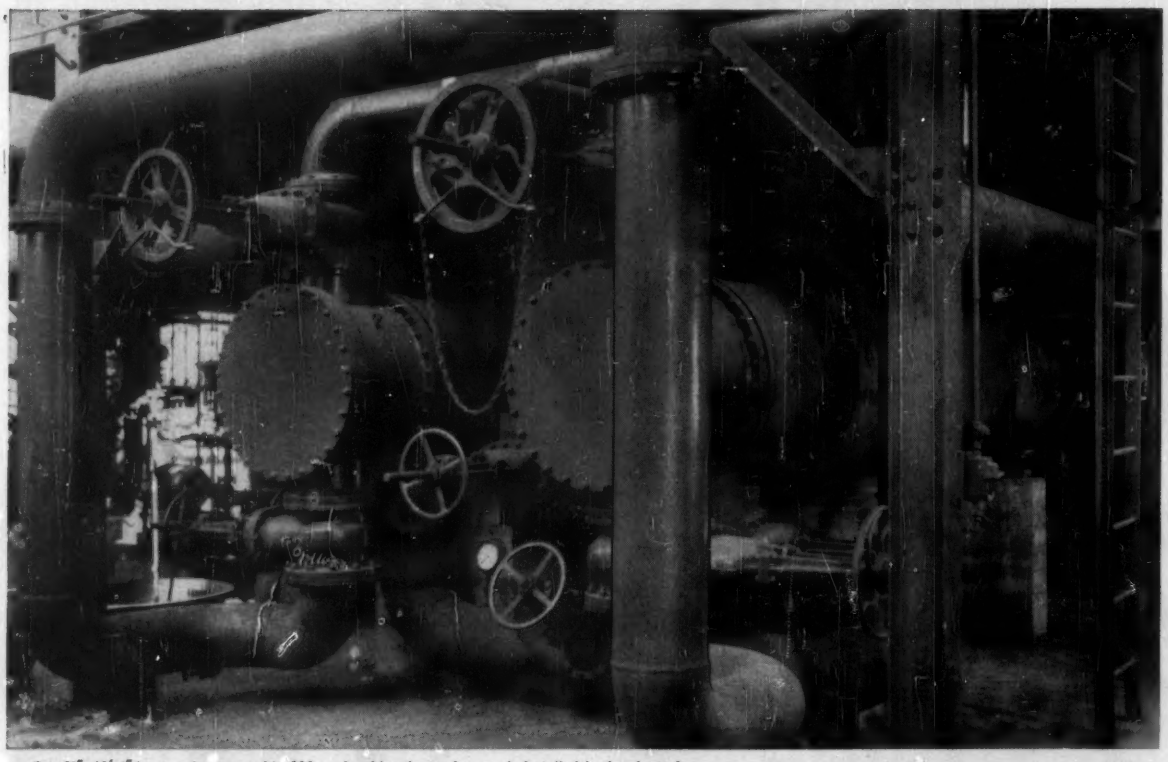
Test your product in the Buflovak customer service laboratory

It's easy to check your product by running a test in the lab spray dryer. Here you can work with skilled engineers to obtain accurate performance data and actual samples of your spray dried product . . . see particle characteristics . . . examine process efficiency.

Contact Buflovak's research department for details on the facilities and services available to you.

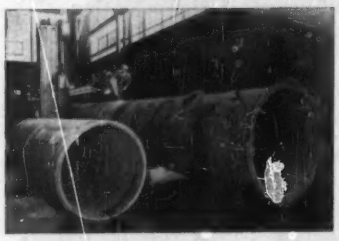
BLAW-KNOX

BLAW-KNOX COMPANY
Buflovak Equipment Division
1551 Fillmore Avenue, Buffalo 11, N.Y.



Two 31" x 19' 4" heat exchangers, with 1800 sq. ft. of heating surface each, installed in the plant of a large Eastern coke and coal chemicals company. In them, flushing liquor from the coke ovens heats a carbonate solution used in a special process for eliminating hydrogen sulphide from manufactured gas.

YUBA HEAT EXCHANGERS...



Engineered to Requirements

Yuba engineers scientifically rate and design heat exchangers to provide maximum heat transfer consistent with good operating practice. And to help rate these exchangers, Yuba has an electronic computer to make the *best* selection from many possibilities.

Yuba's superior engineering insures that initial cost of equipment is kept to a minimum. Proper design means low maintenance, with the end result a profitable operation. You will find Yuba's plants in the East and West thoroughly experienced in working with alloys as well as with time-tested carbon steel.

Contact the nearest office of our nationwide sales organization today and let us give you a quotation.

YUBA CONSOLIDATED INDUSTRIES, INC.

351 CALIFORNIA STREET, SAN FRANCISCO 4, CALIFORNIA

Divisions Manufacturing Heat Exchangers

ADSCO DIVISION, Buffalo, New York

YUBA HEAT TRANSFER DIVISION, Honesdale, Pennsylvania

YUBA MANUFACTURING DIVISION, Benicia, California

YUBA

San Francisco Sales Office:
520 Balfour Building

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U.S.I. CHEMICAL NEWS

July ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

Urethan Applications Grow In Drug, Chemical Fields

Ethyl carbamate, more commonly known as Urethan, has become a useful chemical tool with a wide variety of uses since it was first produced in this country over 20 years ago. Urethan's applications now range from cancer therapy to the manufacture of plasticizers — and useful new reactions are continually being found.

In the pharmaceutical field, Urethan is now employed in the production of tranquilizers, and in the synthesis of many drugs. Its medical applications include the treatment of leukemia and other forms of cancer. Urethan is a mild hypnotic and sedative; is also reported to enhance the effectiveness of penicillin and streptomycin, and to increase the activity of certain enzymes.

Plasticizer producers use Urethan as a gelatinizing agent for cellulose acetate and cellulose nitrate. Cosmetic makers find it an excellent solvent in astringent preparations and hair dyes. Diazo paper manufacturers incorporate it into the light-sensitive layer to yield bright, stable prints.

Urethan is the ethyl ester of carbamic acid and has the chemical formula

$$H_2N-\overset{\overset{O}{\|}}{C}-O-C_2H_5$$

As a chemical intermediate, it reacts with many organic and inorganic compounds to form end products or other intermediates of commercial importance in the dyestuffs, plasticizer, food and drug fields among others.

U.S.I., pioneer producer of Urethan, has a wealth of experience with this wide-spectrum chemical, and can supply information or technical help on applications and reactions.

Polyethylene Closures for Drums Now Self-Venting

Used on U.S.I. Alcohol Drums

A leak-proof, tamper-proof, all-polyethylene closure for containers carrying liquids—tradenamed FlexSpout* — now has a self-venting feature which eliminates the need for other separate vents on shipping containers. The improved spout

MORE →

*® Rieke Metal Products, Auburn, Ind.

Self Venting FlexSpout on U.S.I. Pure Ethyl Alcohol, USP, 5-gallon drum being pulled up into pouring position via new bail on reseal cap.

Promising New Sodium Treatment Developed for Bonding Teflon

Sodium-Naphthalene-Solvent Treatment Claimed More Convenient Than Earlier Teflon Preparation for Strong Bonding to Metals, Rubber and Plastics

A new surface treatment has been developed for joining fluorinated resins such as Teflon to other materials. The resulting ease of bonding will undoubtedly increase Teflon utilization as a corrosion-resistant lining for process equipment and vessels, as a bearing material, and in fluid seals.

The new process, described in U.S. Patent 2,809,130, requires only conventional ventilation, and uses treating solutions that can be stored for long periods. Its advantages over the sodium-ammonia solution surface treatment should bring the new process into wide application for preparing Teflon for adhesion to metals, rubber and plastics.

Bond Strengths Are High

It is reported in the patent that peel tests were made on an epoxy cement bond between the treated Teflon and a phenol-formaldehyde resin — and that the bond was stronger than the Teflon itself. Similar results were obtained in joining Teflon to metal and rubber with a chlorinated rubber adhesive.

How It Is Done

The Teflon surface is bathed at room temperature with a sodium-naphthalene complex dissolved in a solvent such as dimethyl glycol ether. When the surface turns a grey-brown, it is ready for bonding to other materials. A wide variety of common adhesives can be used, including chlorinated rubber types, resorcinol formaldehyde cements, phenolic types, and epoxies.

Preparation of Treating Solutions

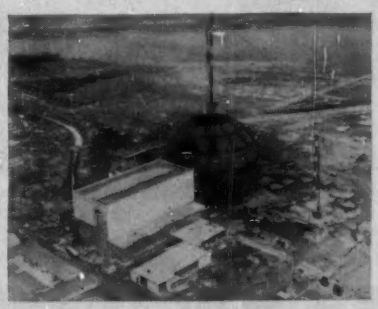
The patent gives a specific example of solution preparation as follows: a liter of a molal solution of naphthalene in a dimethyl glycol ether solvent under a nitrogen blanket is

MORE →

Largest All-Nuclear Power Plant to Contain 44 Miles Of Zirconium Tubing

At Dresden, Illinois, a 180,000 KW all-nuclear power station is being constructed which will contain in its reactor core almost 44 miles of tubing made from zirconium. This Commonwealth Edison boiling water reactor plant will be the largest all-nuclear station in the U.S. when it begins operation in mid-1960.

The tubing is made of reactor-grade Zircaloy-2 and is used as a container for UO_2 fuel pellets. It is to be given special pressure, sonic and corrosion tests, to insure that it meets the rigid tolerances established for this type of tubing.



Sphere to house reactor, and turbine building, for Commonwealth Edison's Dresden, Ill., power plant — to be country's largest all-nuclear station when completed in 1960. Reactor will contain 44 miles of zirconium tubing. (photo courtesy General Electric)

Zirconium metal has an extremely low nuclear cross-section — allowing free passage of neutrons—and makes an ideal cladding material for uranium because it offers minimum interference to the fission process, is corrosion and heat resistant, and structurally strong.

This zirconium tubing order, the largest ever placed, is being processed by Mallory-Sharon Metals Corporation (owned ⅓ by U.S.I.), world's largest producer of special metals such as titanium, hafnium, zirconium, tantalum and columbium. The company uses a U.S.I. sodium reduction manufacturing process which offers advantages in both economy and product quality.

Another ISOSEBACIC® *Acid Patent for U.S.I.*

U.S. Patent No. 2,822,389 on the separation of C-10 dicarboxylic acids has been granted to U.S.I. It is the ninth patent U.S.I. has obtained on its manufacturing process for ISOSEBACIC acid — a new intermediate for the plastics industry. The material is a mixture of three C-10 dibasic acids — 2-ethylsuberic acid, and 2,5-diethyladipic acid, and sebacic acid.

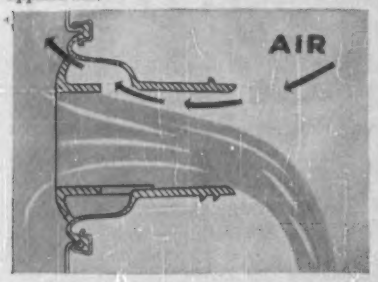
A plant to produce ISOSEBACIC acid in commercial quantity is now being completed at U.S.I.'s major chemical complex in Tuscola, Illinois. Potential applications of the new intermediate include the manufacture of plasticizers, ester lubricants, alkyds, polyamides, polyurethanes, reinforced plastics and in chemical synthesis.

July ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Polyethylene Closures

also eliminates liquid surge or "glug" in pouring. It is claimed that there is no waste or spillage, since the closure will vent in any pouring position, and a controlled flow—large or small—can be maintained. Patent has been applied for.



Cross-section of Self Venting FlexSpout closure.

The new FlexSpout, like the old, is normally recessed during shipping and storage and can be extended for pouring. Addition of a bail to the polyethylene cap, however, makes it easy to pull the spout up into pouring position.

This improved closure will soon be on all 5-gallon containers in which U.S.I. ethyl alcohol is shipped. It offers greater convenience in handling and pouring.

CONTINUED

Teflon

reacted with metallic sodium. Formation of the sodium-naphthalene complex is indicated by the appearance of a greenish color, at which point the Teflon is immersed.

Other investigators have cited the use of finely divided sodium dispersed in xylene or white oil. Preparation and handling are described in a U.S.I. brochure, "Sodium Dispersions" which may be obtained on request.

Those who will be employing metallic sodium for the first time when applying this treatment will find valuable information in U.S.I.'s 40-page book, "Handling Metallic Sodium on a Plant Scale." The book is available from U.S.I. without charge.

Cabot's Extrafine Silica Now Made at Tuscola, Ill.

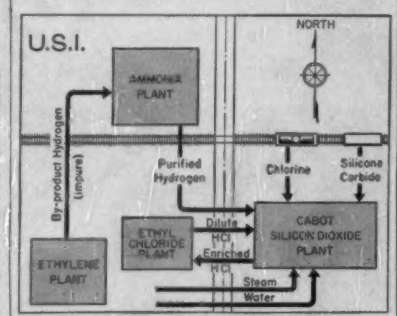
New Plant is Integrated with U.S.I. Production Facilities

A five million pound per year plant for the production of finely-divided silicon dioxide is now onstream at Tuscola, Illinois. Godfrey L. Cabot, Inc. has been importing the product, Cab-O-Sil®, from Germany since 1952. The new Cabot plant is the first in this country to make silica by the German process.

Cab-O-Sil's unique properties are said to derive from this method of manufacture which involves the vapor-phase hydrolysis of silicon tetrachloride in a hot hydrogen environment. The silicon dioxide produced has a particle diameter of 15-20 millimicrons, surface area of 175-200 square meters per gram, purity of 99.99.7%. It has found application in reinforcing rubber polymers, producing stable lubricating greases, coating reproduction papers, adjusting viscosity of paints and inks, and controlling flow properties of a wide variety of industrial powders and liquids.

Cabot chose Tuscola as a plant site because of its economic advantages. Located near U.S.I.'s ammonia and ethyl chloride facilities, the new Cabot plant utilizes raw materials supplied by the U.S.I. processing units, and the U.S.I. ethyl chloride plant uses byproduct hydrogen chloride from Cabot.

• ® Godfrey L. Cabot, Inc.



Flowsheet showing interrelation of U.S.I. and Cabot plants at Tuscola, Illinois.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Glass acid bulbs for accurate quantitative analysis of fuming acids, toxic or volatile chemicals, etc., can now be purchased in commercial quantity. They are said to be of controlled diameter, weight, uniformity of wall thickness; can be made in any desired size. **No. 1370**

Portable kit for field testing of non-fat milk solids is now available. Permits quick determination of solids content before milk goes to dairy. Consists of portable water bath, milk sample tubes, lactometers; weighs 40 lbs. **No. 1371**

Antibacterial compound just developed is claimed nontoxic, nonirritating, noncorrosive, odorless, tasteless, water soluble. This complex silver compound is suggested for liquid soaps, toilet goods, other similar products. **No. 1372**

New pump eliminates contact of moving parts with fluid handled. Intake and outlet consists of one flexible tube passing through pump body and acted upon by kneading action of double rotor. Handles corrosives and abrasives. **No. 1373**

Molybdenum pentachloride — active catalyst for chlorinating aromatics, Friedel-Crafts alkylations and like reactions — can now be obtained in semiworks quantities. Also "plates" molybdenum when reduced by hydrogen. **No. 1374**

New needle-and-glass syringe combination packed in sterile polyethylene bag is now available. Entire unit is designed to be discarded after use. Glass barrel unaffected by solvents during long contact with parenteral fluids. **No. 1375**

All phases of the flexographic printing process are covered in a new, revised, updated edition of an older book. Now on sale, new volume includes sections on copy preparation and halftone printing by flexography. **No. 1376**

New centrifugal filming machine for sterilizing sensitive biological fluids and producing high-potency vaccines by ultraviolet irradiation now in production. Suggested for polio vaccines, blood plasma, liquid foods. **No. 1377**

Fiber glass finishing agent which establishes a better bond between fibers and resins is now available in semiworks quantity. Reported to give better wet and dry strengths to polyester, epoxy, melamine, phenolic laminates. **No. 1378**

For liquid oxygen systems, new thread sealing compound is now available. Is specifically formulated for negligible impact sensitivity, is claimed to have approval of several rocket motor manufacturers. **No. 1379**

PRODUCTS OF U.S.I.

HEAVY CHEMICALS

Sodium, Metallic: cast solid in tank cars, steel drums, pails; bricks in barrels, pails.

Sodium Peroxide, Sodium Sulfite, Sodium Sulfate

Ammonia, Anhydrous: commercial & refrigeration. Tank cars or tank wagons.

Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions

Phosphatic Fertilizer Solution: wet process phosphoric acid.

Sulfuric Acid: all strengths, 60 Baume to 40% Oleum. Also Electrolytic grade to Federal specifications. Tank cars or tank wagons.

Caustic Soda, Chlorine

OTHER PRODUCTS

PETROTHENE® Polyethylene Resins

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, and 2-Ethyl Heptanoic Acid.

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corporation
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Some of the many available desiccants

It takes an expert prescription to dry gas properly . . .

Come to Kemp

Kemp Oriad Dryer protects pneumatic instrument board at Spencer Chemical in Charlestown, Ind. The unit has needed only minor service since its installation in 1950 and has given top performance at all times.

Over 20 *different* desiccants . . . each with its own particular properties and uses. It takes experience to choose the right one and engineer it into a drying system that will exactly meet your needs.

Kemp offers you that experience . . . almost a quarter-century in designing and building drying apparatus. Kemp engineers combine the right equipment and the right desiccant into a unit that brings you dependability, ease of maintenance, and simplicity of operation. For any use . . . guarding pneumatically operated instruments and tools . . . drying process gasses and inerts for blanketing and purging . . . pressurizing anhydrous liquids . . . liquid drying or any of a host of other applications . . . a Kemp Oriad or Convection type dryer will give you high efficiency drying at low cost.

To improve performance and cut costs in your operation, have Kemp engineers recommend a system for your plant. Your Kemp Representative will give you detailed information, or write direct for Bulletin D-100. The C. M. Kemp Mfg. Co., 405 East Oliver St., Baltimore 2, Md.

Kemp Convection Dryers

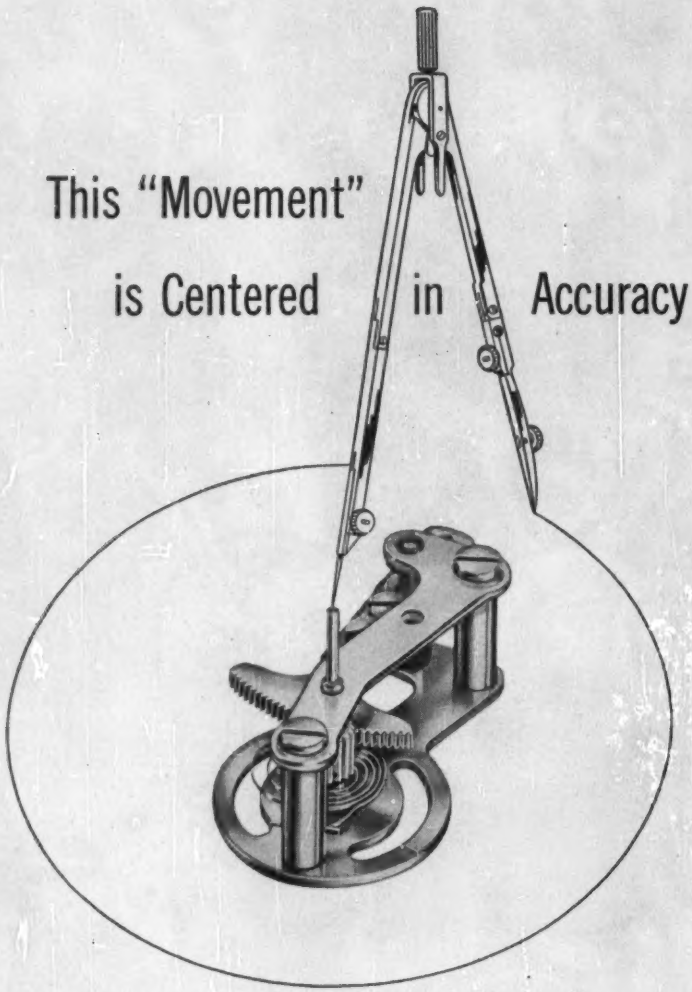
Kemp Inert Gas Generators

KEMP OF BALTIMORE

Kemp Industrial Carburetors

Kemp Oriad Dryers

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

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GI-58

With U. S. Steel's rust-inhibited drum you get positive product protection *plus* two extra purchasing advantages

Here's how to hold down drum costs and still buy top quality.

U. S. Steel, with its unsurpassed rust-inhibited drum, now offers every customer two important purchasing advantages to help save time and money.

1. Full, complete line. U. S. Steel has today's widest selection of steel shipping containers. Pails from 2½ gallons up, drums from 57 gallons down – plus a full line of stainless-steel containers.

Special linings and closures are available, too, so that you can select a container with exactly the right properties for your product, in the most efficient size. Both you and your customer profit.

USS IS A REGISTERED TRADEMARK

2. Punctual deliveries – anywhere. U.S. Steel's enormous production capacity and seven convenient plants assure you of fast, dependable shipments.

You can take delivery by rail or truck. In either case, our kind of service can help you keep inventory problems to a minimum, avoid production stoppage due to fluctuating container supplies.

So before you place your next order for *any* steel shipping container, make it a point to talk to the man from United States Steel.

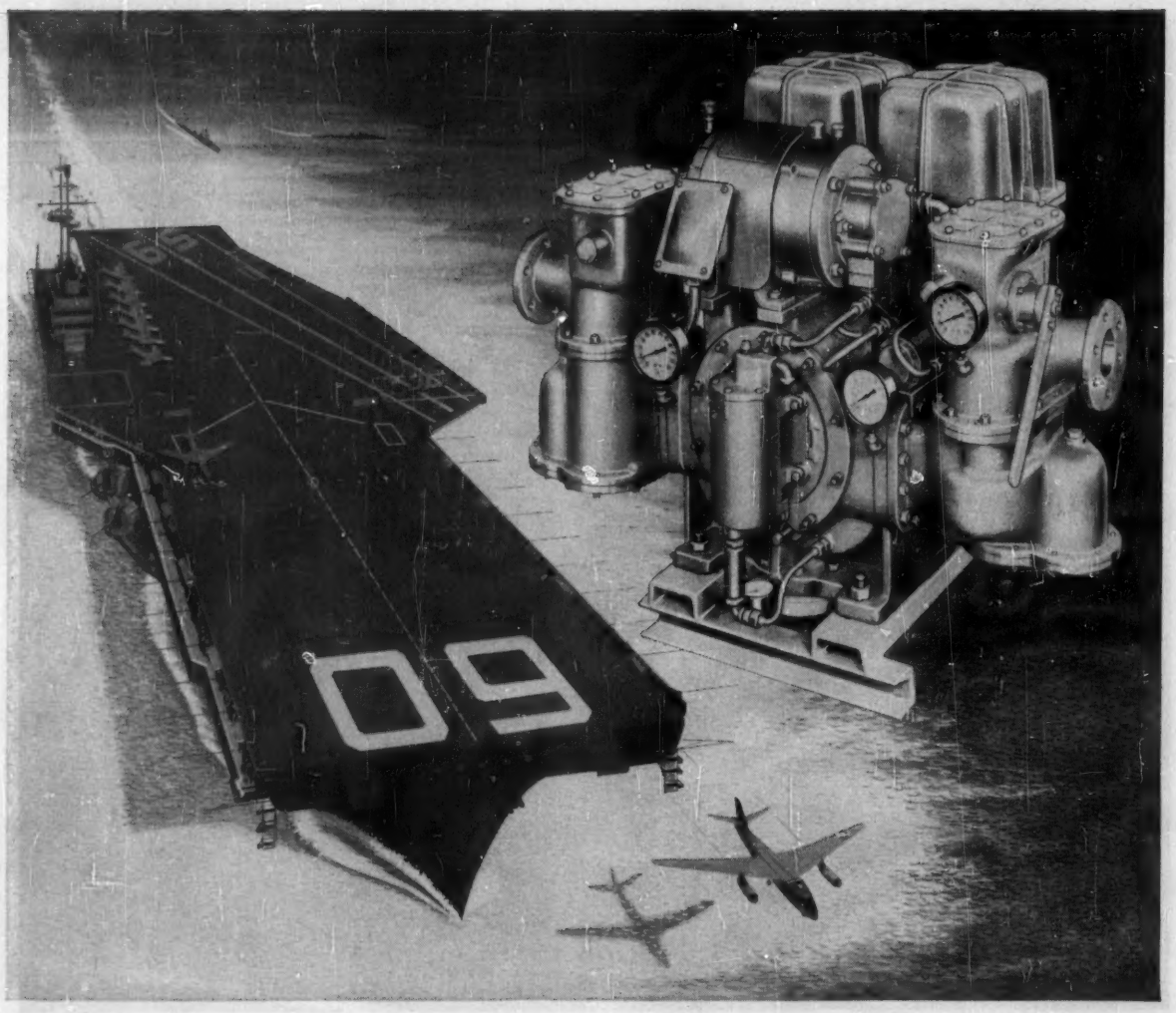
Factories in: Los Angeles, Calif. • Alameda, Calif. • Port Arthur, Texas • Chicago, Ill. • New Orleans, La. • Sharon, Pa. • Camden, N. J.

FAMOUS U.S. STEEL HANDKERCHIEF TEST

Rub a white handkerchief inside any USS rust-inhibited drum—spotless. Reason: each drum is chemically cleaned *after* forming. Zinc phosphate coating goes on over clean steel, inhibits rust.

United States Steel Products Division

USS



How Kanigen® coating helps eliminate rust from jet fuel systems

Fuel systems engineers faced a major problem in corrosion when jet aircraft went to sea. Aircraft carrier systems for fueling planes are aqua-systems—which means that to prevent accumulation of explosive vapors in half-empty tanks, water replaces fuel as it is pumped out of the carrier storage tanks. Blackmer fueling units, made by Blackmer Pump Company in Grand Rapids, Michigan, frequently are used.

High test aviation gasoline does not absorb moisture. Jet fuel does. This moisture, with high salt content, reaching unprotected steel castings, created rust which contaminated the fuel and caused malfunctioning.

Blackmer pumping units, made from steel castings to meet high shock requirements, were protected with KANIGEN® nickel-alloy coating. They were used and evaluated at sea for two years.

The KANIGEN coating was found superior because (1) it gave better initial overall coverage, and (2) the KANIGEN coating did not chip or break away from machine surfaces as some other coatings do.

If you have a corrosion problem, consult our engineers. You'll find *. . . it pays to plan with General American.*

KANIGEN®

is a trademark which identifies chemical nickel coating by GENERAL AMERICAN TRANSPORTATION CORPORATION and its licensees, the product resulting therefrom and compositions produced by them for use in chemical nickel coating.

KANIGEN DIVISION

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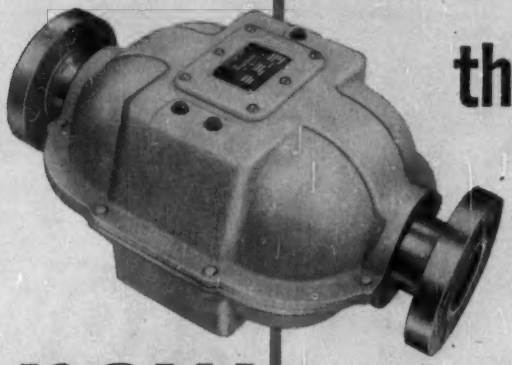

the meter with NO flow restrictions

now handling all these difficult liquids

Foxboro's first Magnetic Flow Meter went "on stream" in 1954. Today, this new-type meter has gained industry-wide application for precise, continuous measurement of difficult process liquids.

The Magnetic Flow Meter is installed as simply as a length of pipe. No seals, purges, meter runs, or straightening vanes are required. It connects by standard electric cable to remote Dynalog Electronic Recorder. Over-all accuracy of the system is ±1%. And the meter even measures reversing flows.

With easy-to-measure liquids, or with tough ones like those listed below, the performance-proved Foxboro Magnetic Flow Meter provides flow measurement with no line restrictions. For complete details, write today for Bulletin 20-14B. **The Foxboro Company, 367 Neponset Ave., Foxboro, Mass.**

CHEMICALS

ammonium nitrate solution
phosphate slurry
rayon viscose
magnesium carbonate slurry
phosphoric acid slurry
detergent concentrate
rosin size
starch solution
rubber copolymer
liquid latex
soda ash
sulphuric acid
70% sodium hydroxide
soap flow
styrol
magnesium hydrate

FOOD
beer
grape juice
apple juice
pineapple juice
tomato juice
milk
starch slurry
sugar syrup
coffee slurry
molasses

METALS AND MINING
pickling acid
sand slurry
ferrous chloride
limestone shale slurry
bauxite slurry
gilsonite slurry
aluminate liquor
uranium ore slurry
thickener mud
cement slurry
flue dust slurry
acid wastes

OIL INDUSTRIES
drilling mud
phosphoric acid
ethenol extract
scrubber recycle water
urea solution
nitrate solution
spent acid
sodium silicate & water
sodium chloride brine
tar-sand slurry

PULP & PAPER
all types of pulp stock
cooking liquors
spent liquors
bleaching chemicals
lime mud slurries
sizes
alum
dyes

WATER & SEWAGE
activated sludge
fresh water
raw sewage
digested sludge
primary sludge
return activated sludge

METER SIZES RANGE FROM 3/16 INCH TO OVER 6 FEET PIPE DIAMETER

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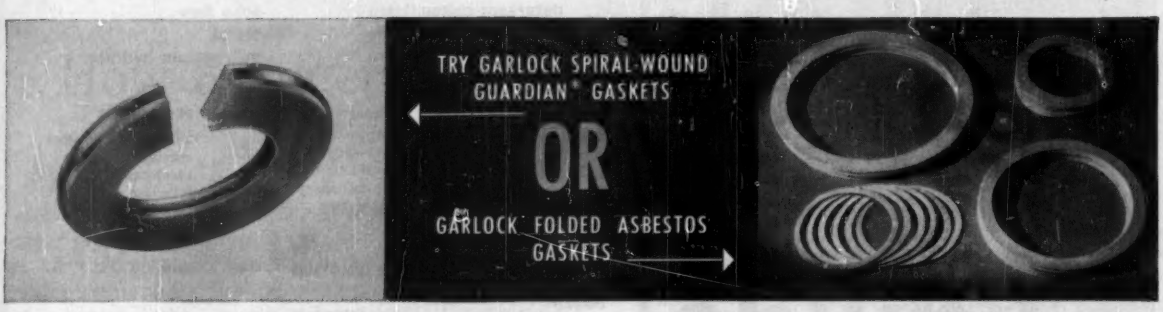
MAGNETIC FLOW METERS

Sealing against high temperatures?



Garlock Spiral-wound Guardian Gaskets provide safe, positive sealing at temperatures to 1050° F. and pressures to 2500 psi. . . . and under lighter bolt loads, too! They are recommended for sealing against oils, steam, gases, liquids and most chemicals. In no other type gasket can you vary the compressibility to meet different requirements. They are constructed of spiral wound strips of V-shaped metal alternated with layers of asbestos paper or Teflon. Type metal and filler depend upon application. Ask for folder AD-104.

Garlock Folded Asbestos Gaskets are recommended for use against steam or gases to 600° F. where surfaces are irregular or pitted. They are most commonly used on boiler manholes and handholes, or on flanged joints of column stills or other equipment requiring a soft gasketing. Made of wire-inserted asbestos cloth, specially treated to withstand high temperatures, the gaskets are folded, formed and pressed to produce any desired shape.

Guardian Gaskets and Folded Asbestos Gaskets are just two more examples of the famous "Garlock 2,000" . . . two thousand styles of packings, gaskets, and seals for every need. The *only* complete line. You can ask your local Garlock representative for his unbiased recommendations. Or, write for Gasket Folder AD-162.

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For prompt service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Did You Ever Hear of 400-S-2?

400-S-2 is a form which details all metering variables. It gives us the information needed to recommend suitable meters for any liquid used in or around your plant. Write or mail the handy coupon.

If it's a liquid . . . that can be poured or piped

ROCKWELL CAN METER IT!

(Corrosive liquids, too!)

We can't tell you how to make your product, but we can meter it! For that matter we can meter most any liquid used in making or processing your product . . . and to your advantage. With Rockwell industrial meters you can batch, blend and control formulas with precision. You can guard costly inventories, control costs. And with Rockwell automatic quantity control valves you can save time and money on repetitive operations. Find out now about the size and type Rockwell meter that will fit your service needs to a tee. Write or use the handy coupon.

INDUSTRIAL METERS
another fine product by
ROCKWELL

CLIP COUPON—MAIL TODAY

ROCKWELL MANUFACTURING CO.
Pittsburgh 8, Pa.

Gentlemen
I am interested in measuring _____
(Name of Liquid)
Pipe Size _____"
Working Pressure _____psi Temperature _____°F max.
Max. Flow Rate _____gpm Min. Flow Rate _____ gpm
Your Name _____
Company _____
Street _____
City _____ Zone _____ State _____

IS YOUR INDUSTRY LISTED HERE?

- Abrasives
- Aeronautical
- Automotive
- Brick and Tile
- Ceramic
- Cement and Concrete
- Cosmetic
- Disinfectants
- Electrical Manufacturing
- Electroplating
- Enamel
- Engraving and Electrotyping
- Feed Stuff, Mineral Feed
- Fertilizer
- Food
- Glass
- Insecticide and Fungicide
- Laundry
- Leather
- Lithographing
- Linoleum and Floor Covering
- Lubricant
- Match
- Metallurgical
- Metal Working
- Oil Cloth
- Optical
- Paint, Varnish and Lacquer
- Paper
- Petroleum
- Pharmaceutical
- Photographic
- Porcelain Enamel
- Plastics
- Pottery
- Printing Ink
- Pyrotechnic
- Refractories
- Rubber
- Shade Cloth
- Soaps
- Textile
- Veterinary Remedies
- Welding Electrodes
- Wall Paper

HARSHAW CAN SERVE YOU!

Harshaw sells chemicals — thousands of them — for these and many other industries

Here are typical Harshaw chemical products

- Electroplating Salts, Anodes and Processes
- Organic and Inorganic Dry Colors and Dispersions
- Driers and Metal Soaps
- Vinyl Stabilizers
- Ceramic Opacifiers and Colors
- Fluorides
- Glycerine
- Preformed Catalysts, Catalytic Chemicals
- Synthetic Optical Crystals
- Agricultural Chemicals
- Fungicides
- Chemical Commodities

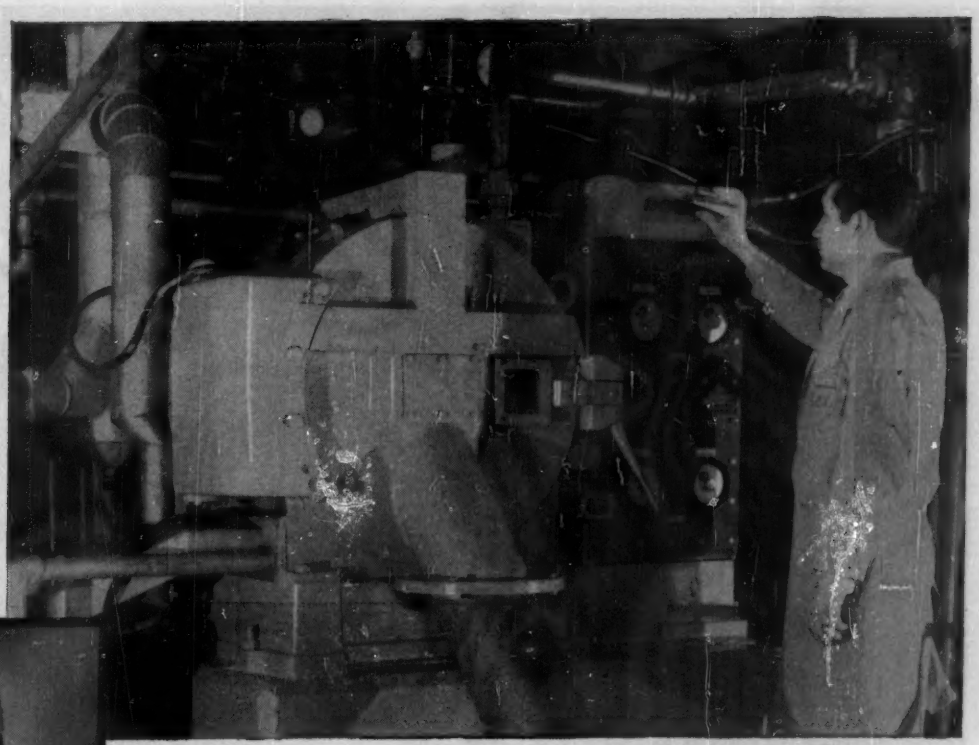
FREE! This 16-page booklet lists the many chemicals available from Harshaw.

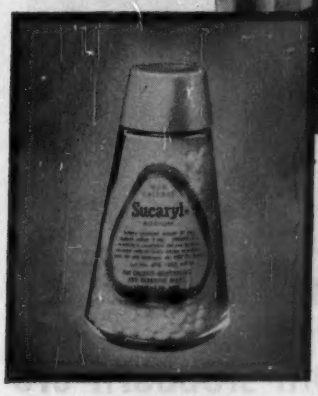
WRITE TODAY FOR YOUR COPY

THE HARSHAW CHEMICAL CO.

1945 EAST 97th STREET • CLEVELAND 6, OHIO

Chicago • Cincinnati • Cleveland • Hastings-On-Hudson, N.Y. • Houston • Los Angeles Detroit • Philadelphia • Pittsburgh



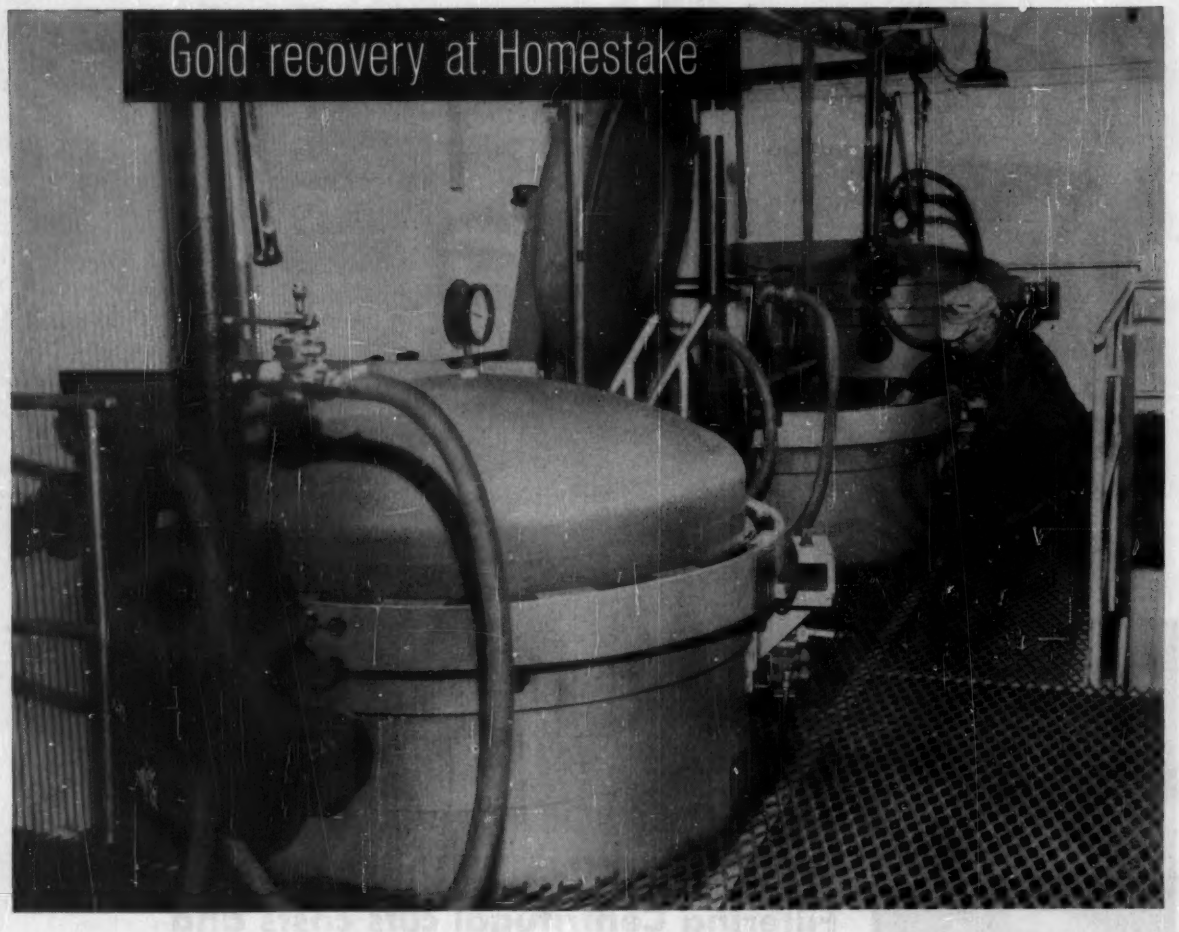


ABBOTT LABORATORIES finds BAKER PERKINS HS Universal Filtering Centrifugal cuts costs and maintains high product quality of SUCARYL

Since installing a Baker Perkins Centrifugal, Abbott Laboratories of North Chicago, Ill., has been able to triple its separation rate in the production of Sucaryl, its popular non-caloric sweetener. The B-P Type HS-20W Centrifugal now gets the same production in 8 hours that required 24 hours in the two center-slung centrifugals that it replaced. Since the centrifuge is totally enclosed, a high product quality has been realized. Operating on a 3 minute cycle, it produces a uniform moisture content crystal (18-20 per cent moisture) from a slurry containing 60 per cent solids. This uniform moisture is considered very important in the subsequent drying operation. As in the case of Abbott Laboratories, Baker Perkins centrifugals mean unsurpassed efficiency and economy . . . B-P centrifugals are built in a wide range of sizes and types, so whatever your needs may be, there's a B-P unit to do the job. Why not have a B-P Sales Engineer recommend the proper size and type centrifugal for your application.

See our insert in Chemical Engineering Catalog for additional information.

BAKER PERKINS INC. CHEMICAL MACHINERY DIVISION SAGINAW, MICHIGAN 359



Process Filters help wring precious metal from stubborn ore

Tough and hard, the gold bearing rock of South Dakota clings stubbornly to the tiny particles of precious metal it contains. To extract gold from the ore, Homestake Mining Co., Lead, S. D., grinds the rock to a fine powder, then dissolves the rare metal with a solution of sodium cyanide.

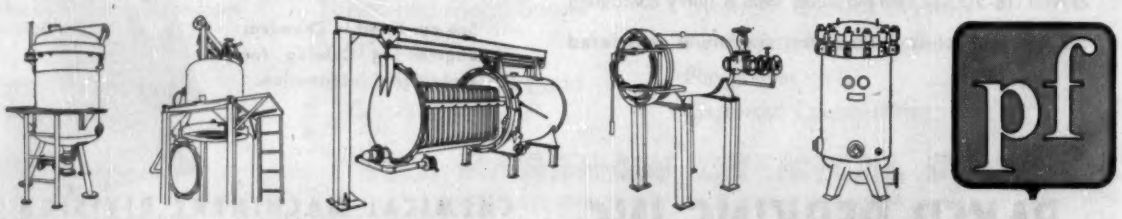
After the ore slurry is passed through Merrill presses, the ongoing solution must be cleansed of all inert matter and residue before the gold is precipitated. Three Process Model V470-2 Filters do the job, clarifying the gold-bearing cyanide stream at better than 54,000 gallons per hour. Covered with Process Quick Change Bags, filter leaves are cleaned by newly-developed rotary sluicing headers which remove the cake rapidly and completely.

Says Homestake Mining Co., "Choice was made mainly on a filter with sufficient capacity to handle the job, yet small enough to fit into the area available . . . Process Filters' service has been satisfactory."

Combining rapid flow rates with proved dependability, Process Filters are raising performance standards throughout the chemical and petrochemical industries. Both standard and specially engineered units are available with a wide range of accessories to meet your process requirements.

Detailed information on the types shown below is yours for the asking. Request one or more Bulletins listed.

PROCESS FILTERS, INC. *(A subsidiary of Bowser, Inc.)*
1807 Elmwood Ave., Buffalo 7, N. Y.

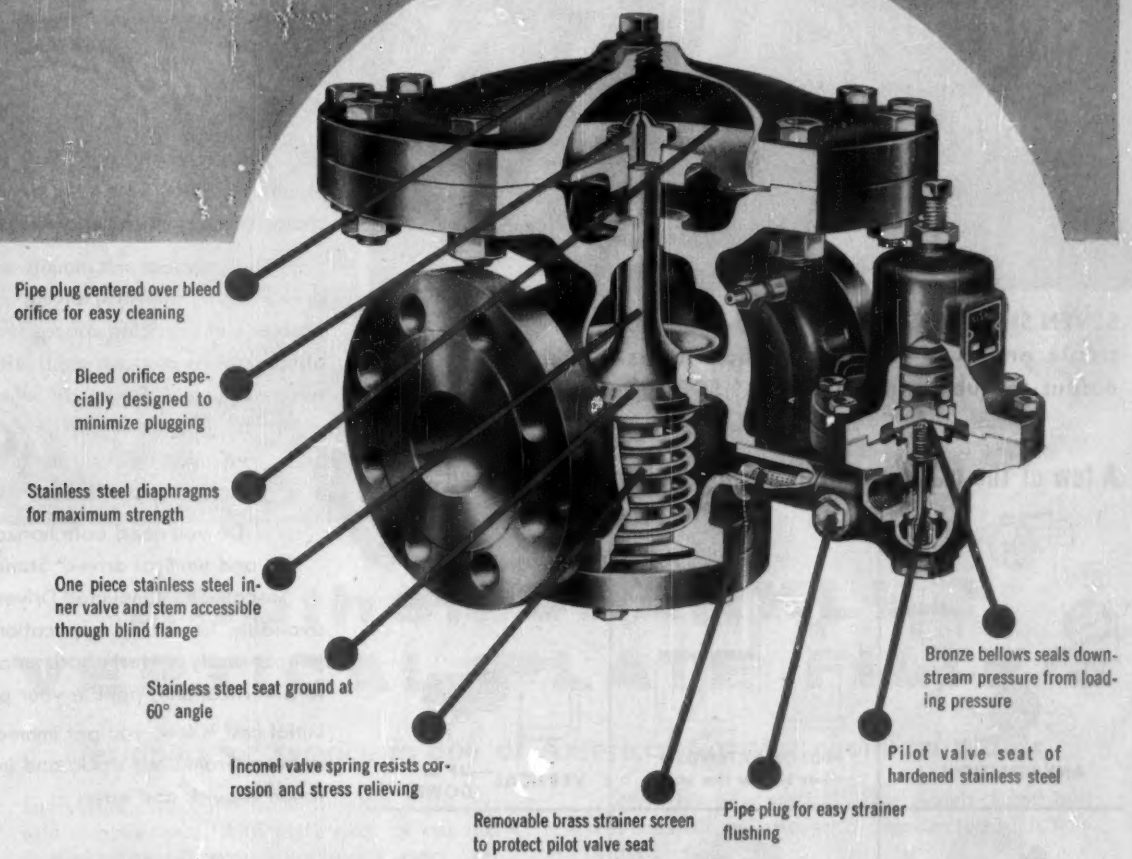


VERTICAL LEAF FILTERS *Bulletin V*
VERTICAL BATCH FILTERS *Bulletin VBO*
HORIZONTAL LEAF FILTERS *Bulletin H*
HORIZONTAL BATCH FILTERS *Bulletin HB*
CARTRIDGE FILTERS *Bulletin C*

THE FISHER® 92B

IMPROVED

TO MINIMIZE PROBLEMS INHERENT IN STEAM SERVICE


Pipe plug centered over bleed orifice for easy cleaning
Bleed orifice especially designed to minimize plugging
Stainless steel diaphragms for maximum strength
One piece stainless steel inner valve and stem accessible through blind flange
Stainless steel seat ground at 60° angle
Inconel valve spring resists corrosion and stress relieving
Removable brass strainer screen to protect pilot valve seat
Pipe plug for easy strainer flushing
Pilot valve seat of hardened stainless steel
Bronze bellows seals downstream pressure from loading pressure

Not content with the enviable performance record of the Type 92A, Fisher engineers have improved this pilot operated pressure reducing valve to a new peak of performance.

For extremely accurate, long trouble-free service, put a Fisher 92B in the line. One pilot with three interchangeable springs provides a range of from 2 to 150 psi. • ***Send for Bulletin D-92 today.***

Engineers with special problems . . . find the ***answer*** *in . . .*

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario

FISHER® Controls

The FALK all-steel Shaft Mounted Drive

- *Versatile*
- *Efficient*
- *Economical*
- *Compact*

To Plant Engineers:

The versatility of the Falk Shaft Mounted Drive makes it the practical choice for many machines in your plant.

This compact unit mounts on the driven shaft, thereby solving many problems of restricted space. You can obtain almost any output speed between 420 and 5 rpm by selecting the proper single or double reduction unit and the proper sheave or sprocket ratio.

Do you need both horizontal and vertical drives? Standard Falk Shaft Mounted Drives are available for either application; or you can easily convert a horizontal unit to a vertical unit, right in your plant.

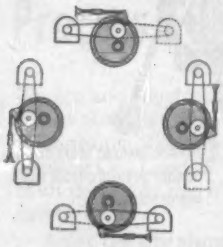
Initial cost is low, you get immediate delivery from shelf stock, and installation is quick and easy.

★

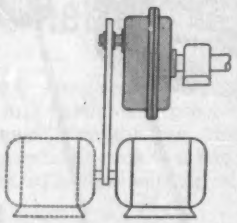
FALK Shaft Mounted Drives are available from factory and distributor stocks *from coast to coast*. See your Falk Representative or Distributor—or write direct for your copy of **Bulletin 7100.**

SEVEN SIZES—½ to 50 HP—420 to 5 rpm—single and two double reduction ratios—output torque ratings up to 31,500 lb-in.

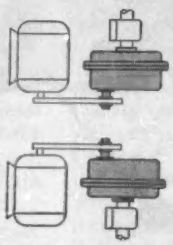
A few of the many ways this reducing unit can be applied—



ANY POSITION



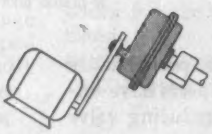
MOTOR EXTENDED —or below the unit



VERTICAL—UP or DOWN

VARIABLE SPEEDS... through use of variable-pitch sheaves—automatic belt adjustment with tie-rod adjustment

OVERLOAD RELEASE... that will slacken belts and cut off power if overload occurs



INCLINED SHAFT... Any standard unit can be mounted in vertical or inclined position by a simple rearrangement of oil drains

THE FALK CORPORATION, 3001 W. CANAL ST., MILWAUKEE 1, WIS.

Representatives and Distributors in Most Principal Cities

Manufacturers of

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

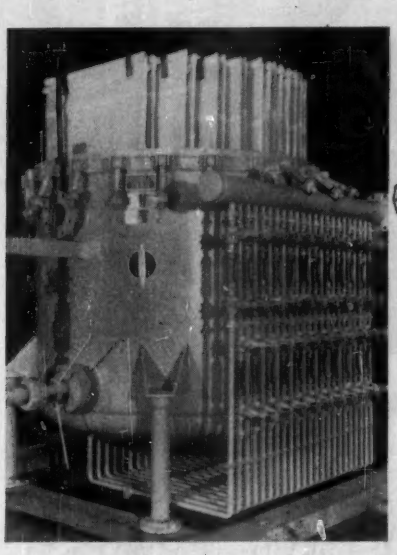
FALK

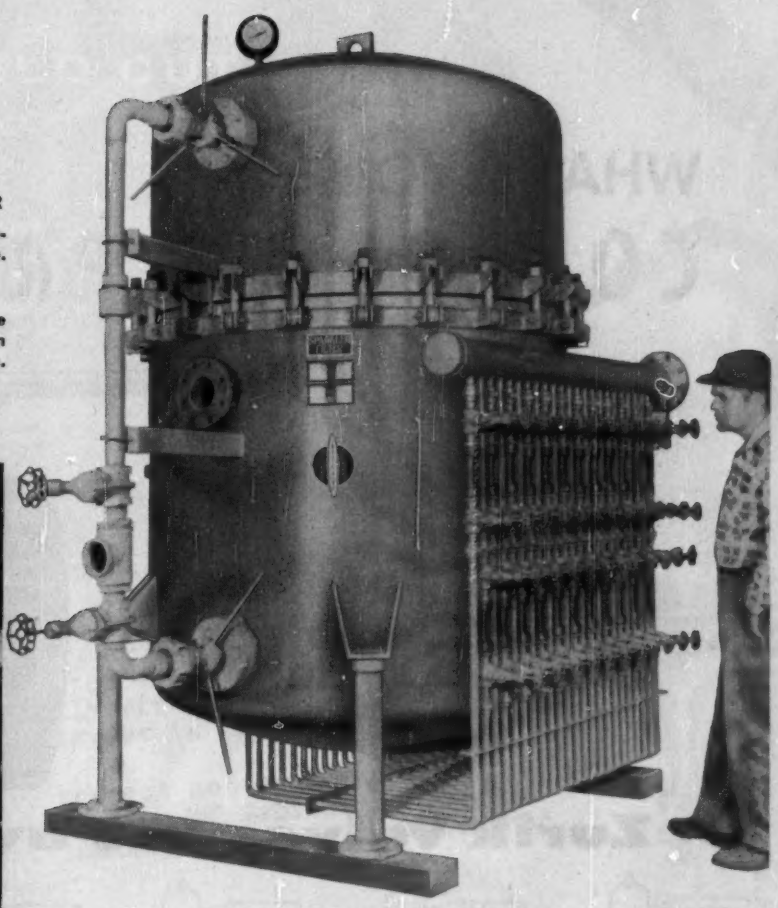
...a good name in industry

SPARKLER MODEL VF FILTER

All Monel metal filter elements designed for filtering caustic solution. 850 sq. ft. of filtering surface.

Custom engineered for performance in areas with restricted headroom and other plant space limitations.





Another SPARKLER VERTICAL PLATE FILTER

Designed for service in one of America's largest chemical plants

Individual plate outlet control valves, sight glasses and sample cocks. Any plate may be cut out of service without interrupting filtering cycle.

This filter is particularly suited for toxic and volatile products. Sealed tank is maintained throughout cleaning and filtering cycles. Available in capacities from 100 sq. ft. to 1000 sq. ft.

Exclusive new vertical plate design. Rigid and non-collapsible plates, with unrestricted high flow center construction.

Spent cake is easily removed without opening filter with the exclusive Sparkler spray sluicing system.

You can depend on Sparkler for the latest developments in modern filtration engineering.

SPARKLER FILTERS

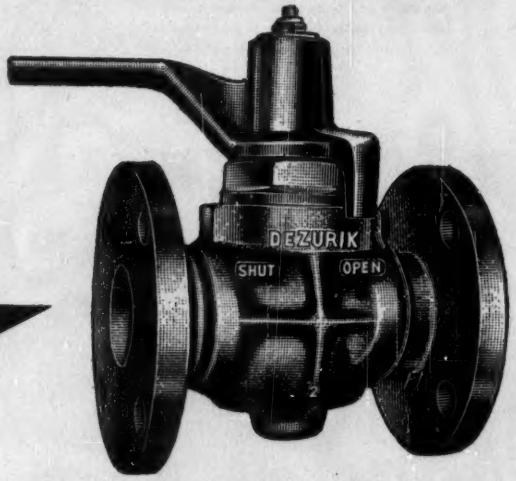
SPARKLER MANUFACTURING CO.
MUNDELEIN, ILLINOIS U. S. A.

Sparkler International Ltd., Manufacturing Plants at Leliegracht 9, Amsterdam, Holland; Toronto, Ontario, Canada; Italy and Australia.

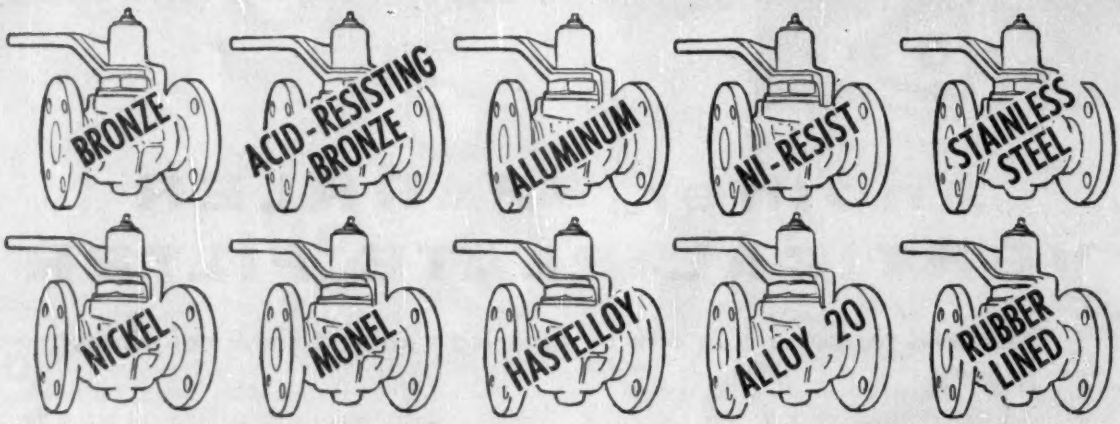
FILTRATION ENGINEERING AND MANUFACTURING EXCLUSIVELY FOR OVER 30 YEARS.

WHAT'S YOUR CORROSION PROBLEM?

HERE'S THE ANSWER!



DeZurik Valves are available in



AND OTHER METALS

PLUGS ARE AVAILABLE WITH HYCAR, NEOPRENE, HYPALON, HARD RUBBER OR TEFLON FACING.

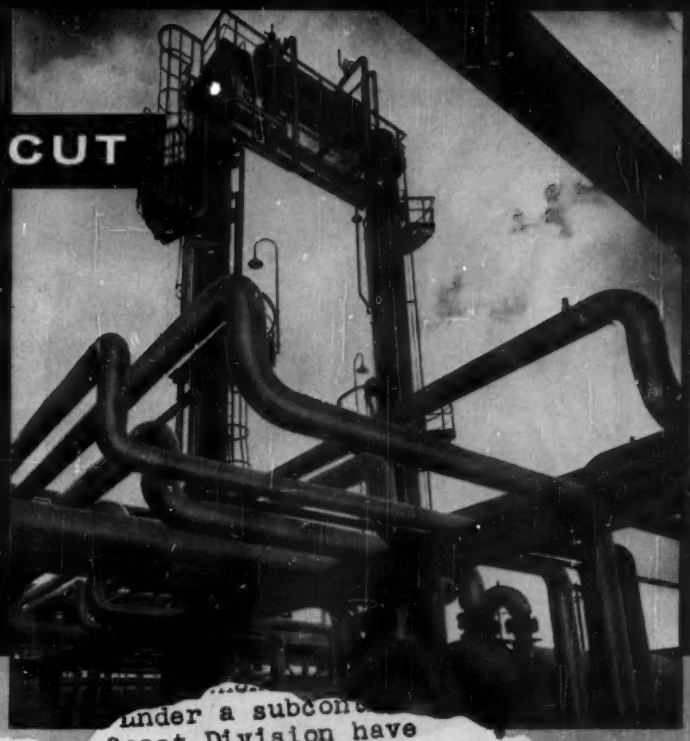
DeZurik Valves' complete range of materials is matched by a complete line of models: manual, pneumatic, hydraulic or electric operation. DeZurik's *exclusive* eccentric action guarantees dead-tight shut-off and easy operation *without lubrication!* For more details on DeZurik Valves write to

Representatives in all principal cities.

DeZURIK CORPORATION
SARTELL, MINNESOTA

NOT ONE FIELD CUT

in all This MIDWEST Shop-Fabricated Piping



...under a subcon...
and I would like to say the West Coast Division have on this job complied fully with the high standards of workmanship for which Midwest is known.

Throughout this entire project not once was a cut necessary to correct any piece of fabrication, and I might add in several instances close tolerances had to be met.

The above was not written on an impulse but as construction superintendent, this means but one thing: fast and low cost erection. Would appreciate your thanking Midwest personally for ...om a construction

Excerpt from letter by:
HOLMES & NARVER • Engineers-Constructors
828 South Figueroa St. • Los Angeles 17

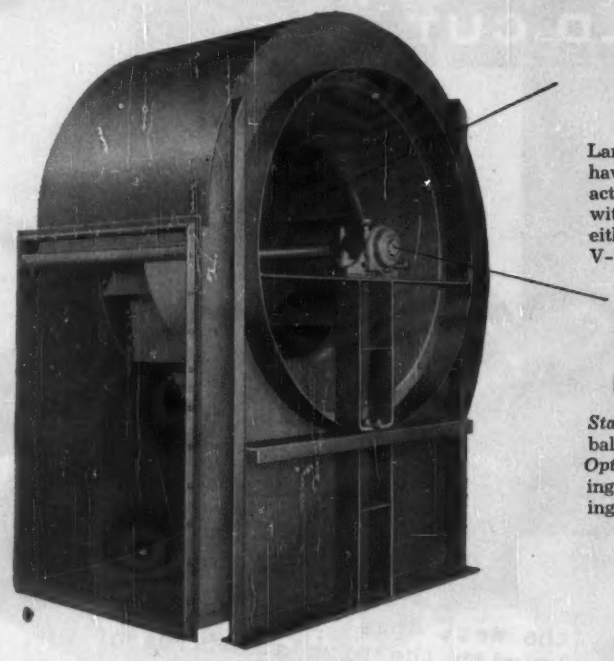
Note particularly the words "*fast and low cost erection*" in the above letter. They characterize Midwest Shop-Fabricated Piping . . . whether for refinery, power plant or industrial installations. In this instance they were written by A. H. Chamberlain, construction superintendent, upon completing the installation of a Houdriformer Unit at the U.S. Oil & Refining Co., Tacoma, Washington.

There are three well-equipped Midwest pipe fabricating shops located to serve economically all sections of the country. Each is staffed by a highly skilled organization using the latest techniques. Each has wide experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. You too will find it to your advantage to call in Midwest whenever you need fabricated piping.

MIDWEST PIPING COMPANY, INC.
Main Office: St. Louis 3, Missouri (P.O. Box 443)
Plants: St. Louis, Clifton, N.J. and Los Angeles

SALES OFFICES:
ASHEVILLE (BOX 446, SKYLAND, N.C.) • ATLANTA 9—72 ELEVENTH ST., N.E. • BOSTON 27—426 FIRST ST. • CHICAGO 3—79 WEST MONROE ST. • CLEVELAND 14—616 ST. CLAIR AVE. • HOUSTON 2—1213 CAPITOL AVE. • LOS ANGELES 33—520 ANDERSON ST. • MIAMI 34—2103 LE JEUNE RD. • NEW YORK 7—50 CHURCH ST. • PITTSBURGH 19, PA.—437 GRANT ST. • ST. LOUIS 4—1450 S. SECOND ST. • SAN FRANCISCO 11—420 MARKET ST.

8033



HIGH-EFFICIENCY STREAMLINE WHEEL

Large-area, backwardly inclined blades have true nonoverloading power characteristic. Medium-speed operation with minimum fan size is ideal for either direct connection to motor *or* V-belt drive.

CHOICE OF HEAVY-DUTY BEARINGS

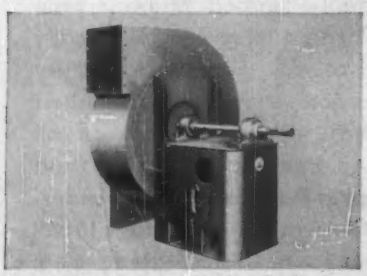
Standard – Heavy-duty, self-aligning ball-bearing pillow blocks.
Optional—Babbitted-sleeve, self-aligning type or roller pillow-block bearings.

American Blower HS Fans hit top efficiency at medium speeds with minimum fan size

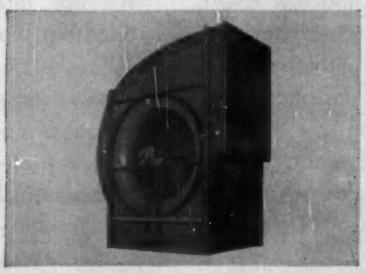
Versatile is the word for American Blower fans. For among this complete line of precision-built fans, you'll find an economical solution to *your* air-moving problem – whether it be ventilating, heating, drying or processing. And the heavy-duty construction of every American Blower fan guarantees you many years of low-cost, minimum-maintenance service.

Nationwide, 73 American Blower factory branch offices are ready to serve you. At your request, skilled sales engineers will help select the equipment to handle your air-moving job best within your budget. Call today! American-Standard, American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

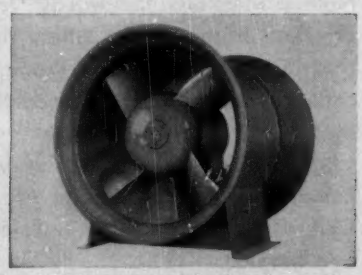
It pays to standardize on American Blower fans for every duty!



Industrial Fans – 3 optional wheels handle air, material, long shavings.



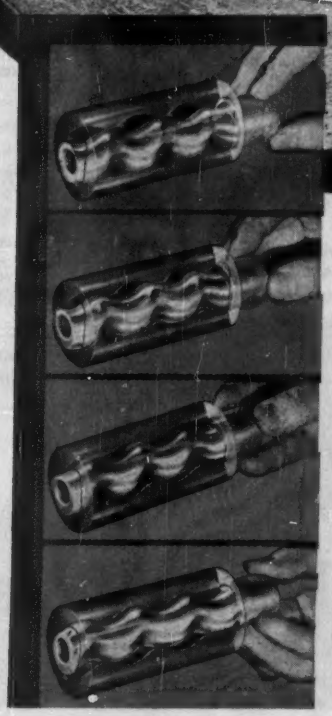
Sirocco Fans – low speed, quiet operation; move more air per revolution.



Axial Fans – move high volumes in minimum space; flexible installation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

IF A CHEMICAL CAN BE PUSHED THROUGH A PIPE...A MOYNO® WILL PUMP IT!



Moyno's exclusive "progressing cavity" principle enables chemical plants to successfully pump hundreds of formerly "unpumpable" materials. These include highly abrasive or corrosive materials, ranging from thin watery slurries to extremely viscous material like rubber dough.

The screw-like rotor revolving in a double threaded stator moves material smoothly, without pulsation, turbulence or agitation. Because the rotor and stator can be constructed of special materials which resist wear, Moynos cut maintenance costs to a minimum.

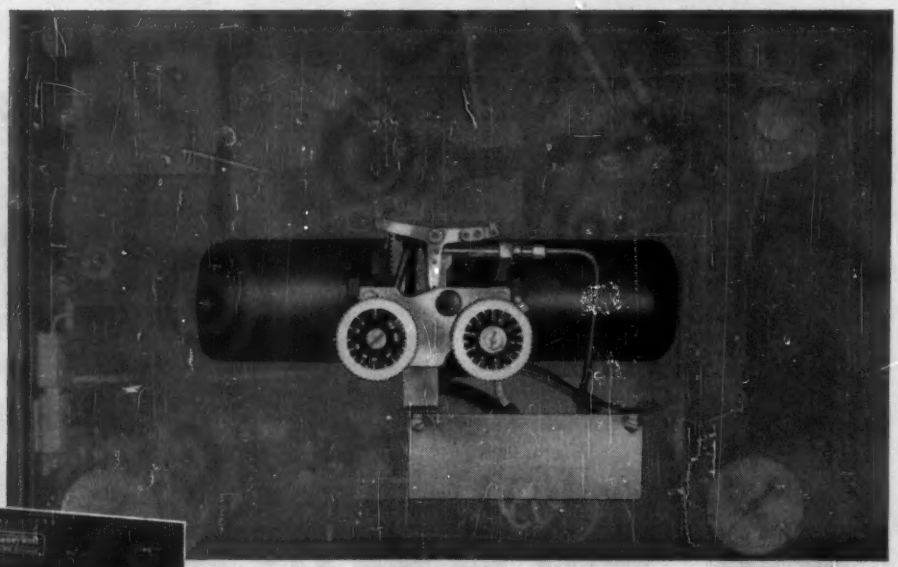
No doubt Moynos can cut pumping costs for you!

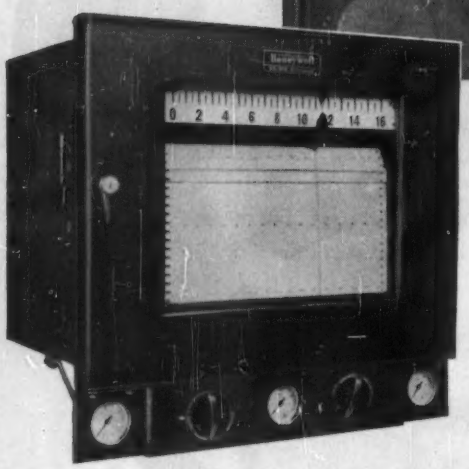
Write for Bulletin 30-CE.

R&M

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO | BRANTFORD, ONTARIO





this instrument makes your tough control jobs easy

ElectroniK Air-O-Line controller measures with ±0.2% accuracy... provides fast, sensitive control

If your process can't stand any offset, if you insist on reliable performance and hairline accuracy . . . this is the controller for you. Sensitive to changes as small as 3 parts in 10,000, this controller holds the measured process variable right where it belongs.

The *ElectroniK Air-O-Line* controller measures and controls temperature, pressure, flow, pH —*any* variable that can be changed into an electrical signal. By standardizing on this controller for your most critical processes, you reduce your maintenance burden. The same components are used in both strip and circular chart models.

Maintenance? Hardly any with the *ElectroniK Air-O-Line* controller. Dirt, dust, and dampness are sealed out. Vibration won't affect operation. The three main components of the *ElectroniK* instrument—amplifier, converter, and balancing motor—can be easily replaced if necessary.

This controller has proved itself in thousands of tough applications. It's the product of pioneering experience in electronic instrumentation . . . made by the world's largest instrument manufacturer . . . backed by the world's largest instrument service organization.

Call in your local Honeywell field engineer for a discussion of your application. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

ElectroniK Air-O-Line FEATURES

- Pneumatic proportional-plus-reset control
- Proportional band widths adjustable from 1 to over 200%
- Automatic reset rates from 0 to 14 repeats per minute
- Rate action unit easily added where needed
- Factory-calibrated within limits of ±0.2%
- Hermetically sealed converter
- Totally enclosed balancing motor
- Sealed liquid-filled *Air-O-Line* unit with single, clog-free restriction
- "Building block" construction for easy interchangeability of components

H HONEYWELL

Honeywell

First in Controls

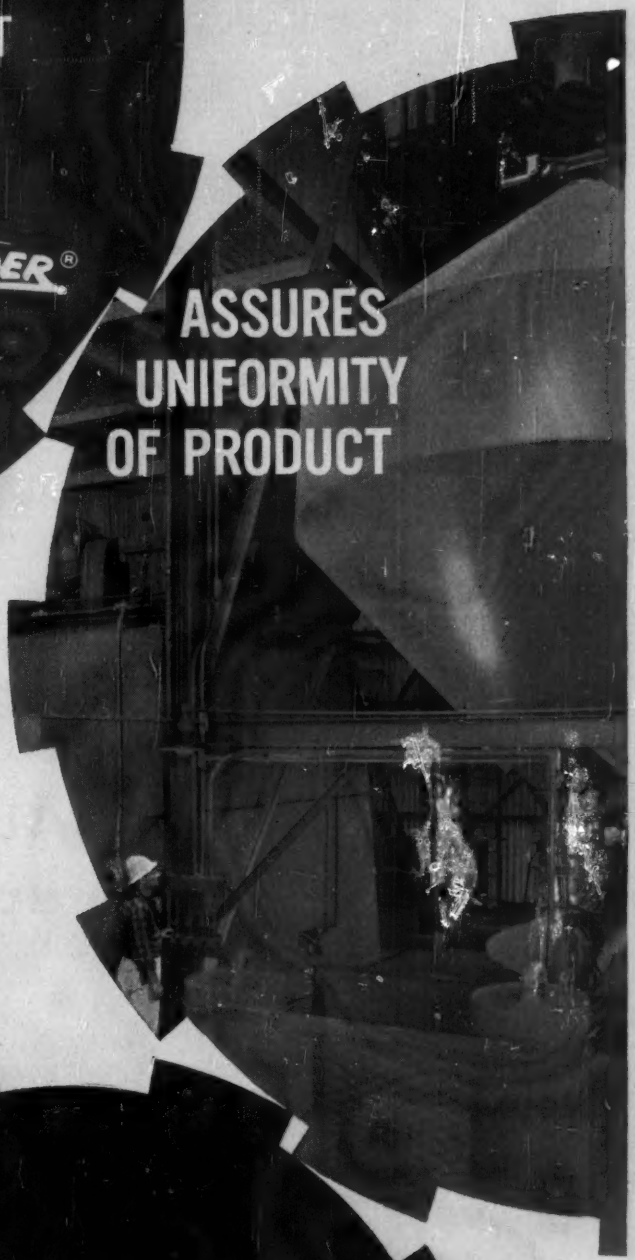
IN W. R. GRACE'S NEW

50,000,000 lb
POLYETHYLENE PLANT

AT BATON ROUGE, LA.

THIS 16-FOOT

Patterson THORO BLENDER®



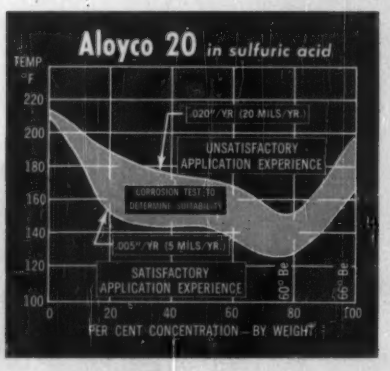
ASSURES
UNIFORMITY
OF PRODUCT

In the world's largest plant of its kind, W. R. Grace & Co.'s brand-new, high-density polyethylene GREX is blended in this single, 16-foot diameter Patterson ThoroBlender to achieve maximum uniformity. Air-fed from storage bins to the giant machine, the poly pellets touch only stainless steel as they are rapidly blended to a completely homogeneous, top quality product before packaging. ● Do *you* have an exacting blending requirement? Regardless of scale, from laboratory-size to carload lots, check PATTERSON!

ADVANCED
PROCESS EQUIPMENT
OF ENDURING SATISFACTION

THE Patterson FOUNDRY AND MACHINE COMPANY
A Subsidiary of Ferro Corporation
East Liverpool, Ohio

THE Patterson FOUNDRY AND MACHINE COMPANY (CANADA) LIMITED
Toronto, Ontario



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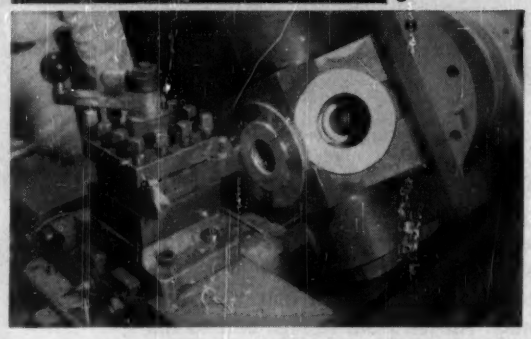

D

A. Your Problem in handling corrosives is discussed with a specialist when you sit down with an Aloyco Sales Engineer. He handles only one line, knows his business.

B. Right Alloy for your application is based on 29 years of specialized experience in the field plus continuing research in Aloyco metallurgical labs.

C. Valve Casting is made from Aloyco design in Aloyco foundry, only foundry ever built to produce pressure-tight Stainless Steel Valve castings, exclusively.

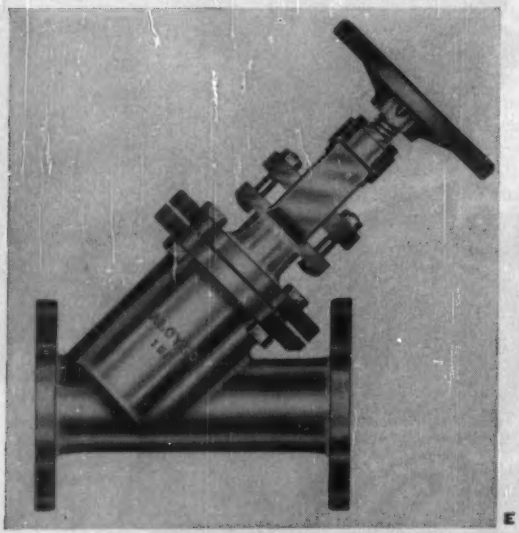
D. Special Techniques in machining stainless steel, plus most modern equipment in Aloyco plant assure you precise tolerances, trouble-free performance.

E. Aloyco Y Valve, shown here in various stages of production, is one of Aloyco's complete line of valve types, alloys, sizes, pressures—including nuclear valves.

BEHIND EVERY ALOYCO VALVE...

specialization

... to help you handle corrosives


E

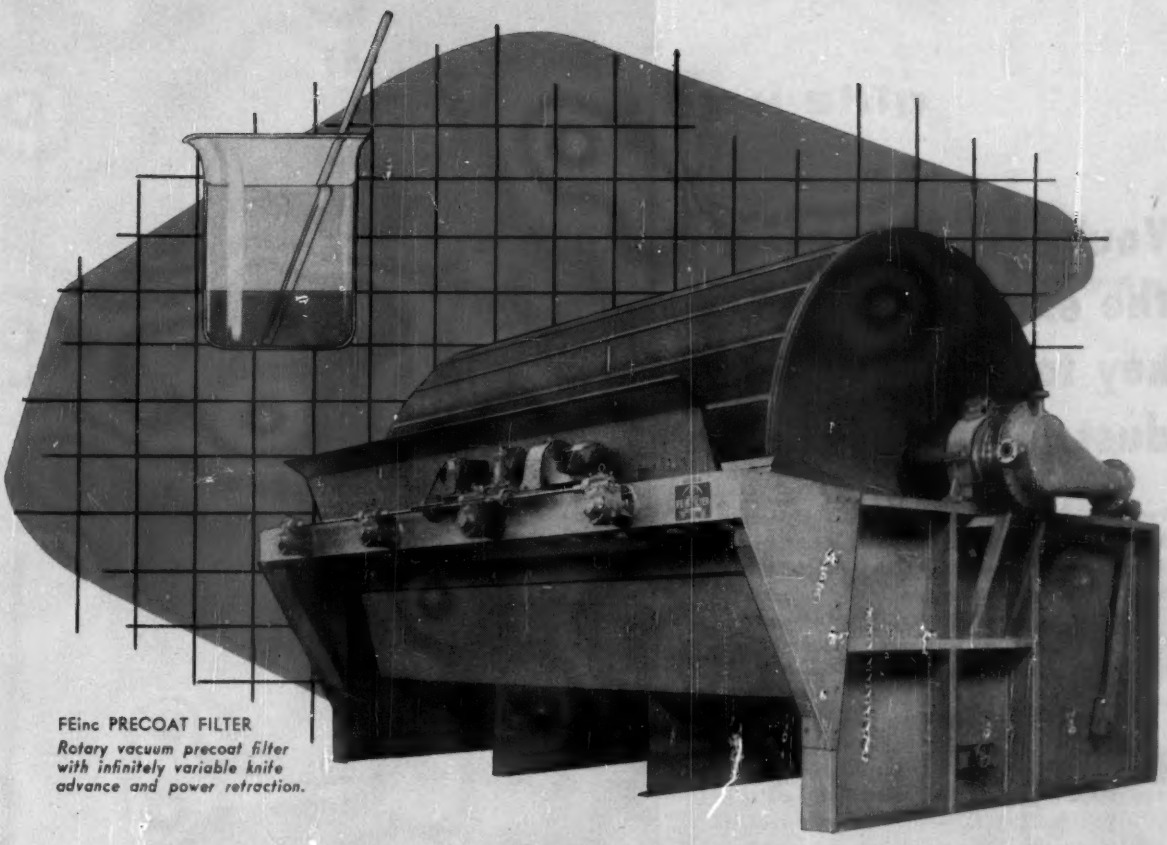
Valves often look alike—even stainless steel valves. But they won't necessarily perform alike when you get them into the line.

Here are some of the special skills and facilities that make the difference between Aloyco valves and others. Some of the "extras" you get with Aloyco valves are staying power, minimum maintenance, trouble-free operation in severe as well as mild corrosive service. Doesn't it make sense that the one company specializing in the manufacture of Stainless Steel Valves exclusively is your best source of supply?

B.2

ALLOY STEEL PRODUCTS COMPANY

1301 West Elizabeth Avenue, Linden, New Jersey



FEinc PRECOAT FILTER
Rotary vacuum precoat filter with infinitely variable knife advance and power retraction.

Custom Filter Design

BEGINS WITH YOUR FILTRATION PROBLEM

Your processing requirements are king at FEinc. They dictate the type of filter to be built, its size, the materials used, and the special refinements necessary to assure highest possible operating efficiency.

For example, a FEinc Precoat Filter designed to meet your particular needs pays off fast in trouble-free operation, dryer cake discharge and high clarity of effluent.

If you require higher output in limited floor area and a long filtration cycle coupled with the above advantages, FEinc *custom design* can give it to you.

Send us your filtration problems. Specific recommendations provided without obligation.

See our insert in Chemical Engineering Catalog

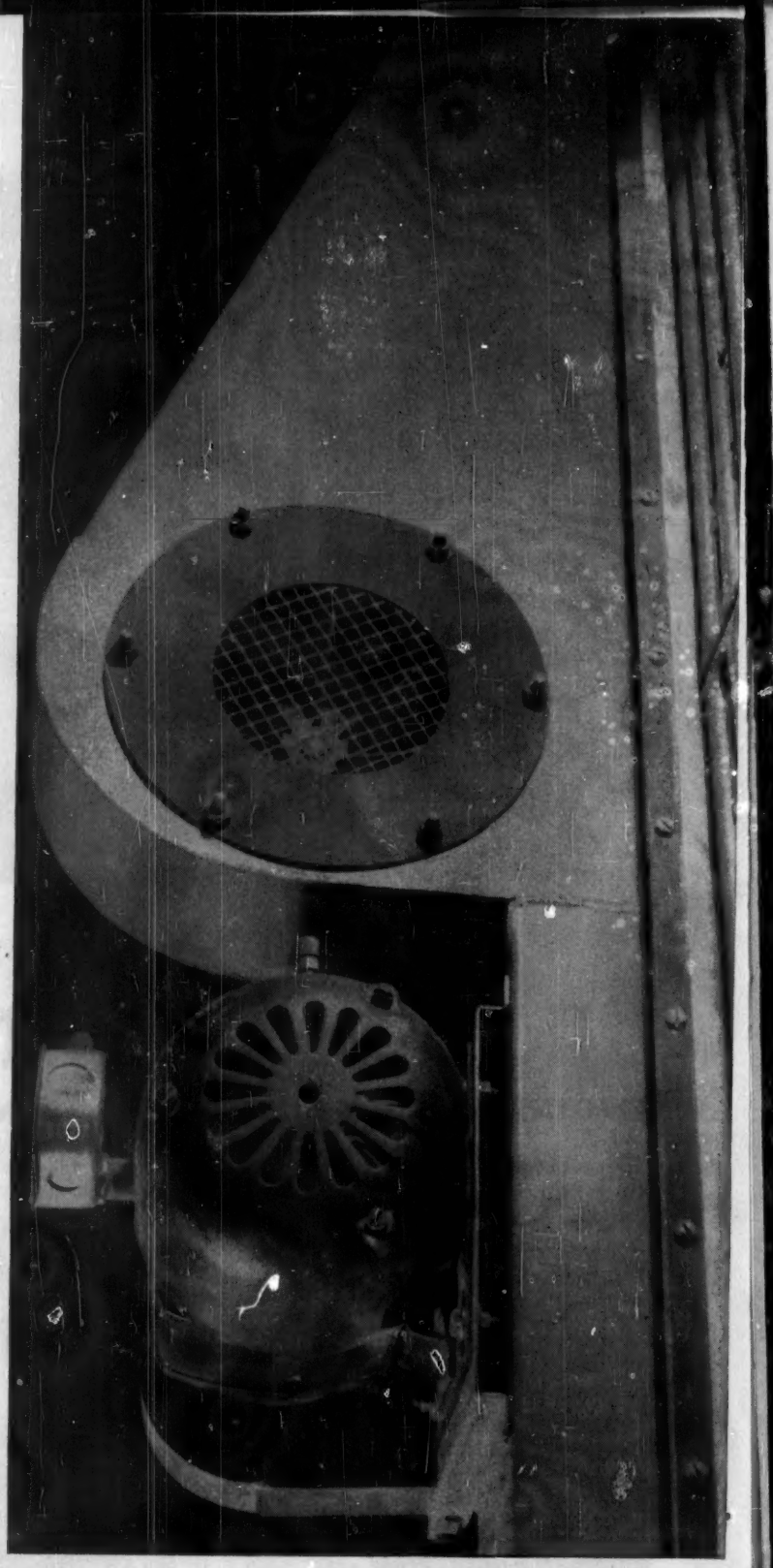
For a Bigger Yield **FE INC.®**

FILTRATION ENGINEERS
AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS

STRING HORIZONTAL SCRAPER

SPECIALISTS IN LIQUID-SOLIDS SEPARATION

You're looking at the exclusive key to continuous dust collecting!



You are inside a Pangborn Dust Collector. And this is Pangborn's traveling manifold . . . the exclusive self-cleaning development that permits continuous suction at highest efficiency. The result is the incomparable performance of cloth type collectors with minimum resistance to air flow and with no shutdown required.

Typical Pangborn engineering . . .

This advance is particularly important in collecting finely-divided dry dusts. But the Pangborn engineering it typifies is important to *any* dust-producing plant. It is not enough to place a dust collector within a plant. An efficient dust collecting system must be *scientifically* planned, designed and constructed to handle effectively a specific dust problem. This *thinking* is incorporated into every Pangborn proposal.

. . . that can help you

One of Pangborn's comprehensive line of dry and wet dust collectors can be utilized in a Pangborn-engineered dust system to solve *your* dust problem . . . whether it involves any kind of fine, coarse, dry, moist, corrosive, hot or obnoxious dusts.

The Pangborn engineer in your area will be glad to take off his jacket and go to work for you. He is a dust *expert* and will discuss your individual problem at no obligation. And, for more information, write for "Out of the Realm of Dust" to: PANGBORN CORP., 2600 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment.*

Pangborn CONTROLS DUST

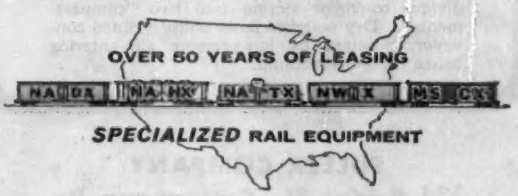
if you ship

chemicals...

GAIN THESE FOUR FEATURES OF NORTH AMERICAN SERVICE

TANK CARS specially lined or custom built to your requirements for safe, economical movement of chemical products.

REPAIR SHOPS strategically located for fast, continuous maintenance of all cars leased to shippers and railroads.



BRANCH OFFICES in market centers staffed by transportation specialists who stand ready to help you overcome your shipping problems—*anytime*.

FIFTY YEARS of shipping experience gained in serving the fast growing chemical industry.

NORTH AMERICAN CAR CORPORATION

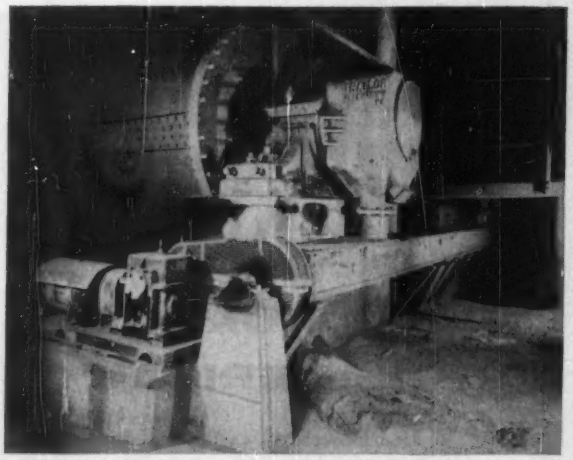
NORTH WESTERN REFRIGERATOR LINE COMPANY
MATHERS HUMANE STOCK TRANSPORTATION COMPANY

231 South La Salle Street, Chicago 4, Illinois

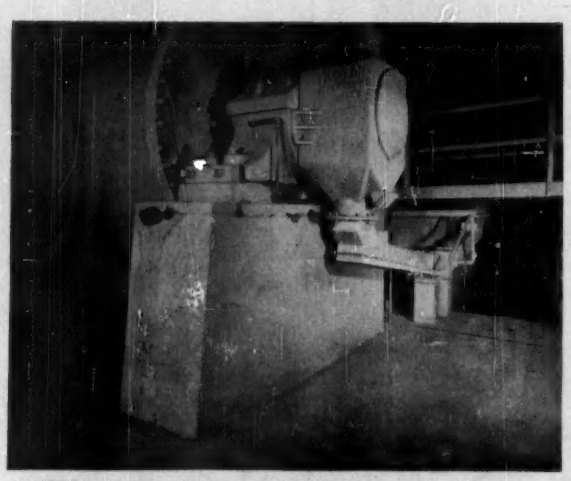
A NATIONWIDE ORGANIZATION WITH BRANCH OFFICES IN IMPORTANT MARKET CENTERS

DALLAS • FOND DU LAC • ST. PAUL • ST. LOUIS • TULSA • SAN FRANCISCO • NEW YORK

The Arithmetic of Materials Handling



BEFORE: **Dirt, noise and mechanical breakdown** were constant problems in this cement plant, where two mechanical conveyors were used to collect raw materials. A 5 h.p. motor driving auxiliary equipment wasted valuable space and power, required frequent maintenance. Spillage clean-up wasted costly man-hours.



AFTER: **Clean, simple, quiet.** Notice the difference two 8" F-H Airslide® fluidizing conveyors have made. No dangerous moving parts. Nothing to lubricate. Auxiliary equipment and foundations are gone. Power needs are now only 1/6 of previous needs. Fluidizing saves wear and maintenance.

AIRSLIDE® Fluidizing Conveyor

minimizes material loss . . . maintenance . . . moving parts

If you are now handling dry, pulverized materials, the F-H Airslide Fluidizing Conveyor can help you stop noise, and air-pollution, as well as speed flow and reduce maintenance cost.

Simplicity Itself

F-H Airslides fluidize dry, pulverized materials with low pressure air.

These materials literally flow at high speed, down the inclined conveyor. Power requirements are small.

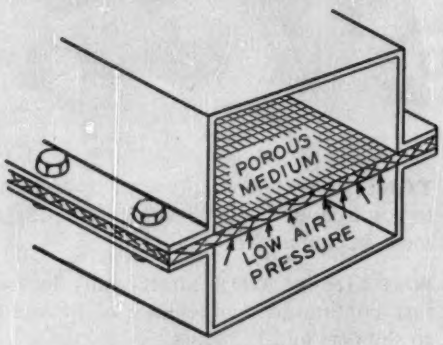
Flexibility, Low Cost

For unlimited applications, Airslide conveyors take up little space, and can be used singly and in combination with other Fuller pneumatic conveying systems. The movement of fluidized material can be around corners, between floors, through walls—nearly any conveying distance.

Better Housekeeping

Can Fuller conveying systems help eliminate your housekeeping problems—cut your maintenance and handling costs? Write today, outlining your problem in handling dry, finely-divided materials. Fuller will gladly make appropriate recommendations.

"Pulverized Materials Flow Like Water!"



AIRSLIDE PRINCIPLE: Porous supporting medium divides conveyor section into two "compartments". Dry material flows down inclined conveyor, fluidized by low-pressure air entering beneath porous medium.

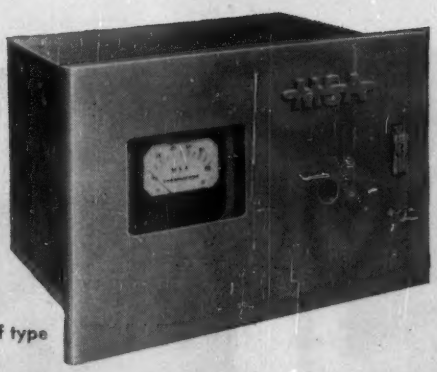
FULLER COMPANY GENERAL AMERICAN TRADE MARK

Fuller
pioneers in harnessing AIR

FULLER COMPANY
134 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Birmingham • Chicago • Kansas City • Los Angeles • San Francisco • Seattle

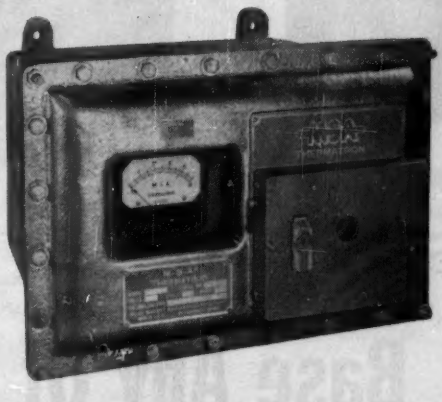
4483
FH 59

"See Chemical Engineering Catalog for details and specifications".



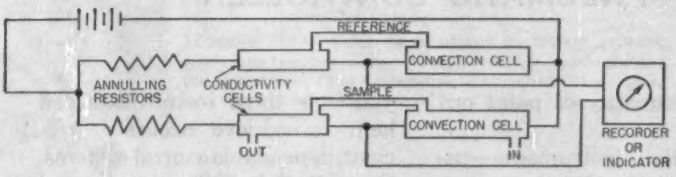
Non-explosion-proof type

A non-explosion-proof type of M-S-A Gas Thermatron with recorder mounted in cubicle



Explosion-proof type

M-S-A® Gas Thermatron continuously analyzes for one component in multi-component gas mixtures



Schematic Flow and Wiring Diagram

This unique development in gas analysis instrumentation combines thermal convection and thermal conductivity effects to provide selective measurement of a single component of a mixture without "scrubbing out" interfering components.

MSA has been applying its knowledge of gas analysis to specific customer problems for over 30 years. Latest and most unique solution to some of these problems is the M-S-A Gas Thermatron.

This unit selectively analyzes for one component of at least a ternary mixture of gases (without removal of any component) by employing both thermal conductivity and thermal convection properties of the gas.

Other standout features: Calibration is possible over very narrow or very wide ranges (0-100% Gas). Construction is rugged. Operation is stable. Maintenance is simple, infrequent. High accuracy and speed of response are inherent characteristics.

In process control, you can use the selective M-S-A Thermatron for analysis of components in hydrogenation, ammonia synthesis, hydrocarbon synthesis and other processes.

In the area of atmosphere/combustion control, you can analyze for CO_2 or H_2 in atmospheres containing H_2, CO_2, N_2, CO and water vapor. Or, for CO_2 in flue gases.

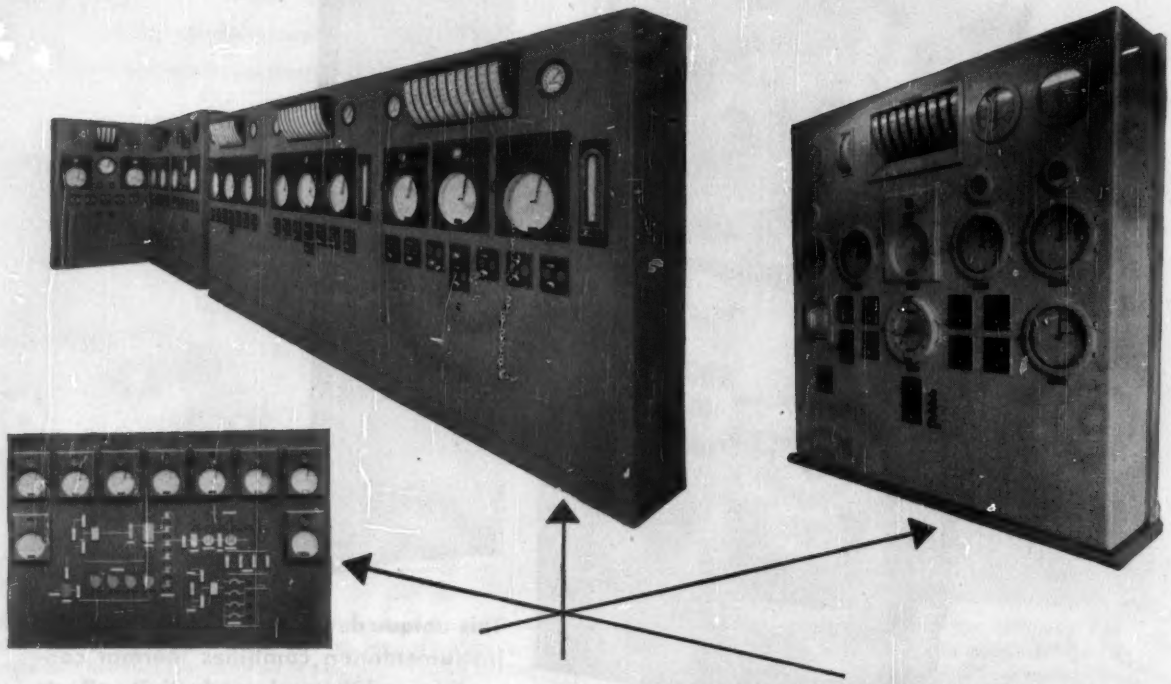
And where gas purity is a factor, the M-S-A Thermatron is helpful in the analysis of argon, hydrogen, helium or water vapor in oxygen, air or nitrogen.

The MSA Instrument Specialist will welcome an opportunity to relate these advantages to your specific operation. Contact him soon. And write us for informative new bulletin on this inexpensive thermal conductivity analyzer.

INSTRUMENT DIVISION

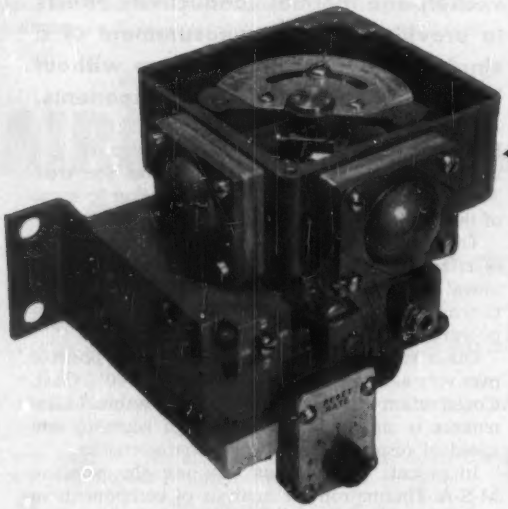
Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

MSA



Base Any Of These

ON THIS



For accurate, efficient, dependable control systems— REPUBLIC'S NEW TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action; local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

REPUBLIC FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

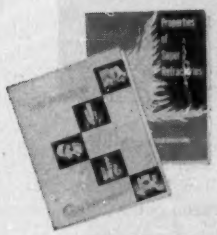
A word to the refractory-wise on . . .

How to make good use of bad times

Remember how management not long ago kept pressuring for "more production." There was no time then for analyzing productive efficiency. So a mild recession isn't all bad . . . *if it gives you badly needed time*—time to spot areas where you can cut operating costs.

For instance: It's highly probable that there are several areas where you could save by substituting one of our special-purpose refractory materials. Especially in "vulnerable" areas exposed to flames, abrasion, corrosion, high heat or heavy loads. Or, in "working" areas where the heat must pass *through* the refractory evenly and rapidly.

For example: One of our customers replaced a high molybdenum alloy cover for a pump handling an abrasive acid slurry with a REFRAX® nitrided silicon carbide cover. The new cover shows practically no wear at all after nearly 2 years in service, while the metal part was severely eroded in less than 6 months. In a separator used to recover fine coal fractions from gritty slimes, heavy wear due to erosion was a problem until a lining made of CARBOFRAX® silicon carbide material was used. Wear is now negligible. In another application, the high heat transfer of CARBOFRAX parts is utilized to dissipate heat with such success that far greater efficiency results. The examples are countless—as are the variety of materials applied.



Here's how you can start cutting costs: It will take less than an hour to read these two booklets about the applications—**and properties**—of Carborundum's unique, new super refractories. Send for them today.

Subscription to "Refractories" is yours for the asking. This technical brochure is published approximately every other month; contains a wealth of information on new refractory materials, lining techniques, etc. Offer limited.

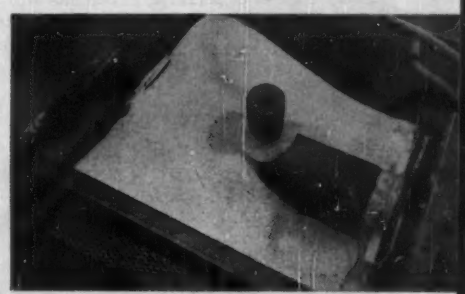
Refractories Division, The Carborundum Company, Perth Amboy, New Jersey, Dept. H-78.

CARBORUNDUM

Registered Trade Mark

EROSION? A water solution of SO_2 passes through the stainless steel pipe (right) and into the REFRAX® nozzle (left) which sprays it into a cooler, as a step toward making sulphuric acid. Ambient temperature is 1800°F. Note the untouched look in the REFRAX nozzle's threaded section, and compare it with the stainless steel.

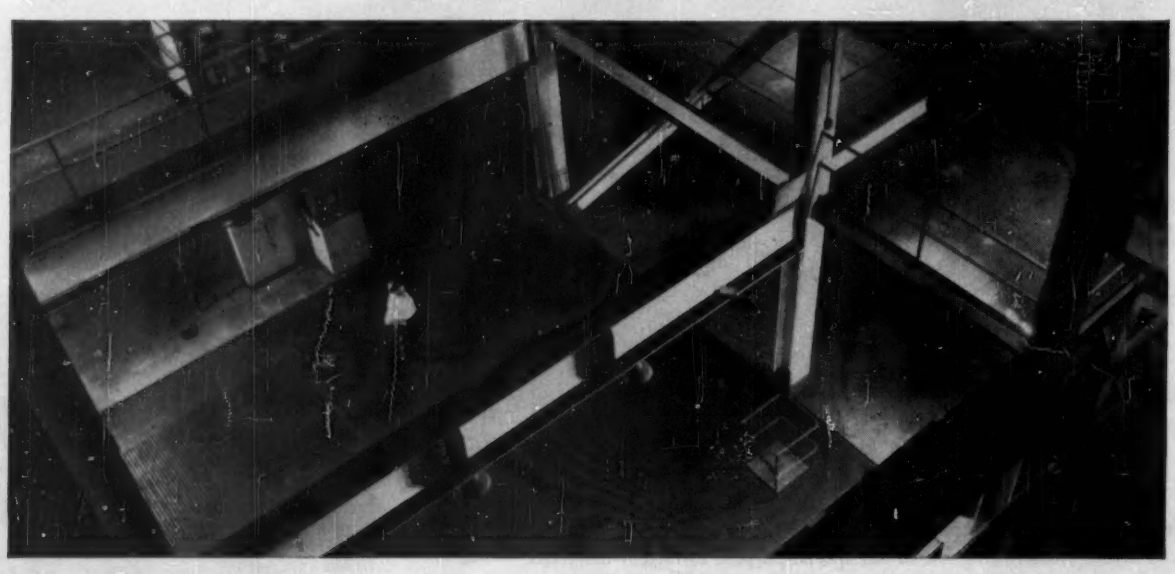
ABRASION? This elbow is part of an air conveyor system handling finely divided cement and asbestos. The charge, at about 150 to 200°F, is highly abrasive. Rubber linings originally used cut through in less than six months. CARBOFRAX® cylinders lining the elbow shown above, despite a service period of 2½ years, are free of pitting and other wear.



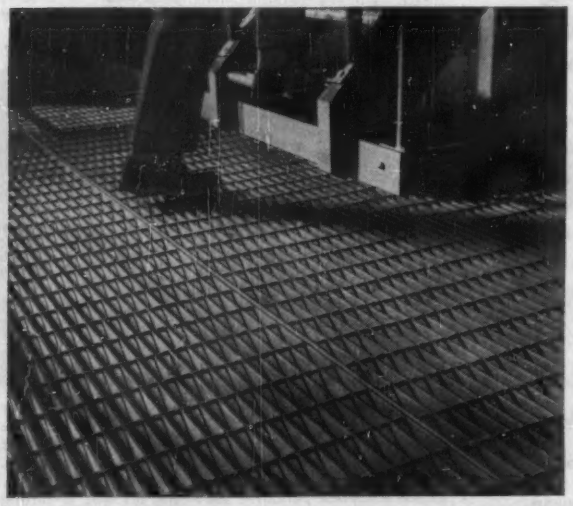
ATMOSPHERES? This furnace is heated to 3000°F by moly wire wrapped around the muffle. The muffle is made of our fused aluminum oxide—and insulated with our granular alumina "bubbles." These refractories have proved stable and durable—are not even affected by hydrogen or cracked-ammonia atmospheres.

designed for flexibility... **Electroforged® for strength**

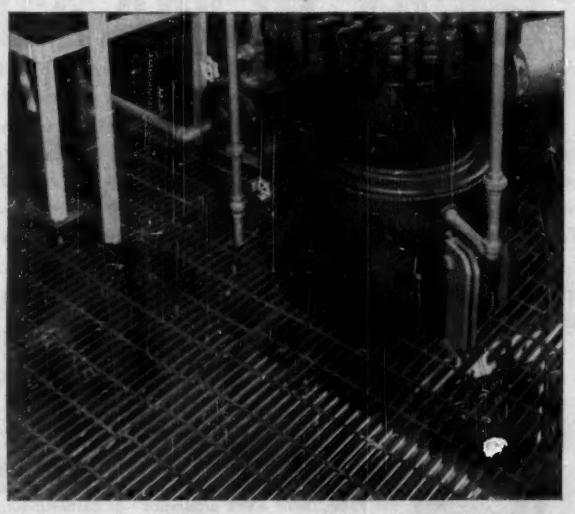
Blaw-Knox Grating fits modern plant needs



More floor space . . . Platforms, mezzanines and loading docks made of flexible Blaw-Knox Electroforged Steel Grating increase storage space, enlarge feeder areas. Easily installed, and easily adapted to changing layouts.



Safer walking . . . on *non-slip* floors, walkways and stairs, Blaw-Knox Electroforged Steel Grating provides rigid one-piece construction and features the twisted cross bar to make every step a safe step.



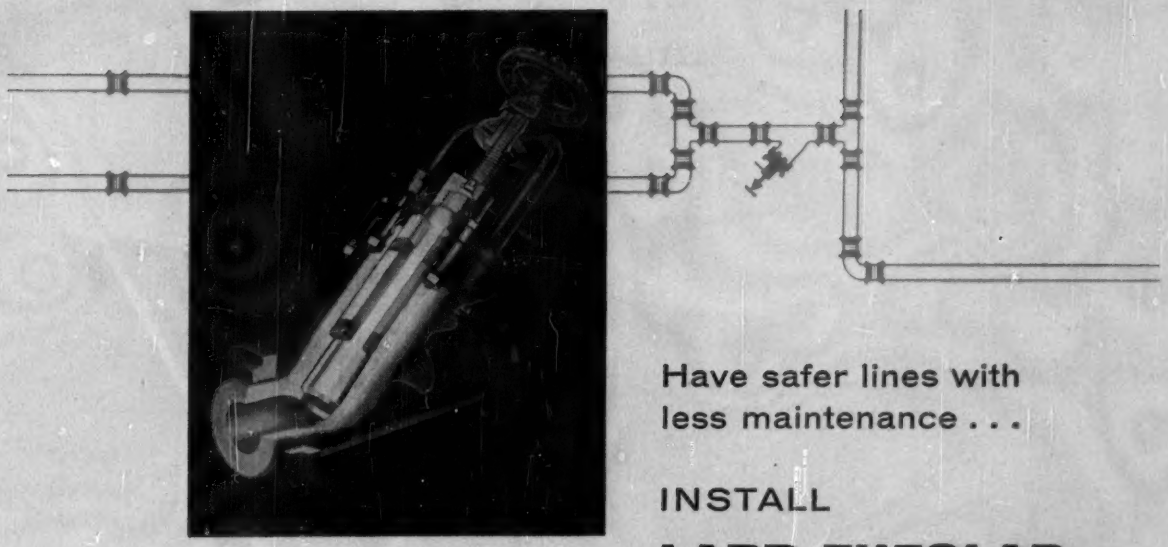
Fits anywhere . . . around pipes, beams and machinery to provide a neat, easy-to-maintain surface. There's nothing to wear, patch or catch dirt. And Blaw-Knox Grating admits more light and air for ideal working conditions.

Write for Bulletin 2527 and see how Blaw-Knox Grating can be custom fabricated to meet your plant improvement specifications.

BLAW-KNOX

BLAW-KNOX COMPANY

Equipment Division
Department C, Pittsburgh 38, Pennsylvania



Have safer lines with less maintenance . . .

INSTALL

LAPP TUFCLAD®

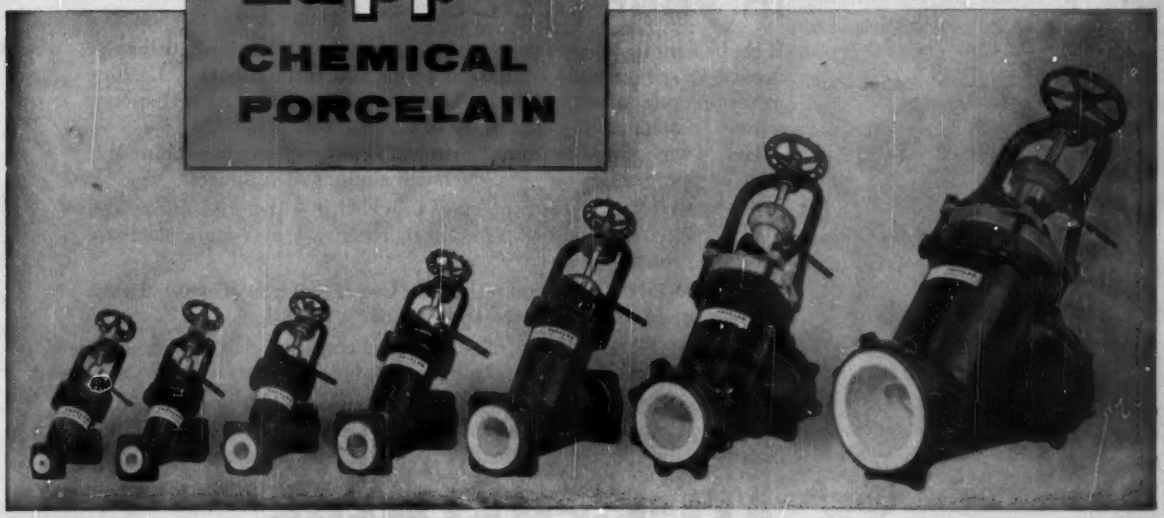
SOLID CHEMICAL PORCELAIN ARMORED WITH FIBERGLASS-REINFORCED PLASTIC

The extra margin of safety essential to many process plants where protection of personnel, equipment and product is vital is assured by the bonding of TUFCLAD fiberglass-reinforced plastic to Lapp Chemical Porcelain. Strong fiberglass fabric is impregnated and bonded in multiple layers to the porcelain with an Epoxy resin of high strength and chemical resistance. It cushions accidental blows—acts as an insulator against thermal shock—and because TUFCLAD is so strong and tough, it will hold operating pressures even when porcelain is damaged by accident. Specify Lapp TUFCLAD Chemical Porcelain and enjoy the purity and corrosion resistance of a solid porcelain system with extra security from TUFCLAD armor.

Y-Valves, as shown, and Angle Valves are available in Lapp TUFCLAD Chemical Porcelain in ½", 1", 1½", 2", 3", 4" and 6" sizes. Also safety valves, flush valves, plug cocks, pipe and fittings (to 8" diameter) and special shapes.

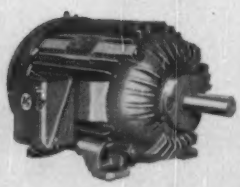
WRITE for description and specifications.
Lapp Insulator Co., Inc., Process Equipment Division 2202 Chestnut St., Le Roy, N. Y.

Lapp
CHEMICAL PORCELAIN



long-run power by Allis-Chalmers

Do you use fluid mixers in your process?



If so, be sure the mixers you buy have motors with the long-run power needed to keep process equipment going 'round-the-calendar. Leading mixer manufacturers, such as Lightnin' Mixer, use Allis-Chalmers motors to achieve this continuity of service.

Here's why Allis-Chalmers "chemical type" motors are winning this wide acceptance among petro-chemical equipment suppliers:

1. **MORE** stator protection provided by extra dips and bakes, plus two coatings of enamel. Result — maximum electrical protection.
2. **MORE** corrosion resistance. Use of cast iron in external parts gives mechanical strength and defies corrosion.
3. **MORE** cooling surface of ribbed construction provides up to 43% more heat radiating area, reduces burnouts to almost zero.

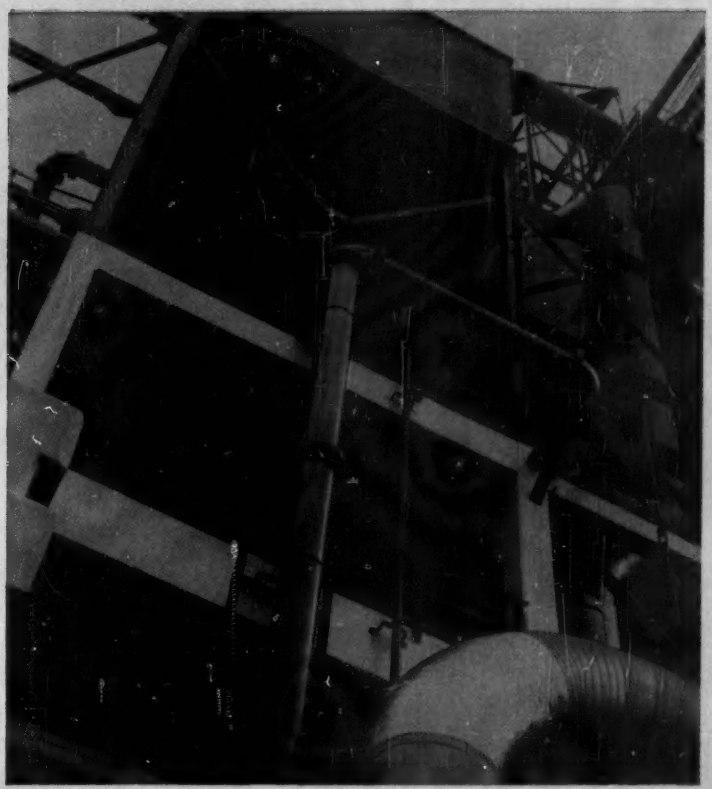
For the long run, specify Allis-Chalmers motors as new components or as replacements. Contact your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

A-5511

ALLIS-CHALMERS

Neoprene lining stops corrosion in refinery cooling lines

Eliminates need for heavy-walled pipe; reduces fabrication and maintenance costs.



Cooling water returning line from condenser. 3/16" lining of Du Pont neoprene stops corrosion by brackish water.

Du Pont neoprene resists corrosive chemicals, oil and heat. It can save you time and money. For example, neoprene solved a maintenance problem for engineers at Cities Service's Lake Charles, Louisiana, refinery. Brackish cooling water rapidly corroded condenser return lines on catalytic cracking units. Using steel pipe with ½" wall thickness merely postponed line failure a little longer than usual. Cast-iron pipe could not be used because it lacked ductility.

Cities Service installed a 3/16" lining of Du Pont neoprene in standard steel pipe with a ¼" wall. The neoprene prevented corrosion despite the fact that the water in these lines contains 18,000 ppm. of salt, plus traces of oil. The water runs through 18 to 24" header pipes 7 stories high at a temperature of 100 to 130° F.

The durable neoprene lining more than paid for itself. It eliminated the need for heavy pipe, and reduced expensive fabrication and maintenance costs.

Neoprene has added advantages that you will find useful in hose, tank linings, gaskets and protective clothing . . . wherever conditions are severe. It is resistant to ozone and weathering, abrasion and cutting. It delivers satisfactory service in a temperature range of −40 to +250° F., and will not support combustion. Mail the coupon below for more information on the properties and many industrial uses of neoprene and HYPALON®, Du Pont's newest synthetic rubber.

ELASTOMERS IN ACTION HYPALON® • NEOPRENE

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

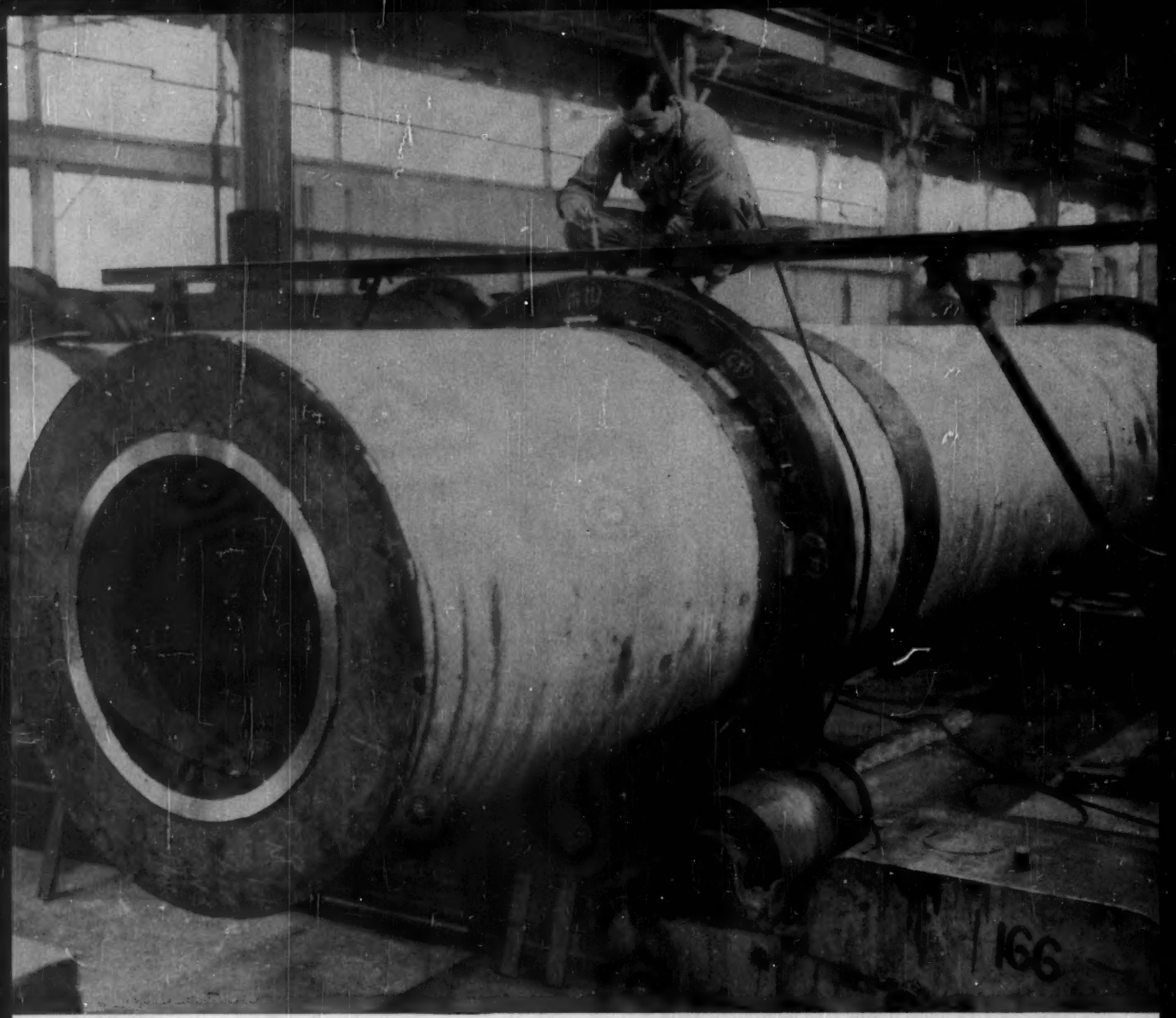
☐ I am particularly interested in _____

☐ Send me a free copy of *The Du Pont Elastomers* (a review of the properties of neoprene and HYPALON).

☐ Add my name to the free mailing list of the *Elastomers Notebook* (contains articles based on the uses of Du Pont elastomers in industry).

E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. CE-7
Wilmington 98, Delaware

Name _____
Firm _____
Address _____
City _____ State _____



1600° temperature dries salt in Stainless Steel

You're looking at a Stainless Steel rotary salt drier. It's used to demoisturize salt, one step in making high octane gas.

C. O. Barlett & Snow Co., Cleveland, Ohio, built the drier with Stainless Steel because of all the materials tested, Stainless Steel stands up better under the tremendous heat—1600°F.—of the combustion gases used to dry the salt. And because Stainless is corrosion resistant, it can handle the salt, which has a moisture content as high as .5% when it's fed into the drier.

The salt comes out of the drier in a dry and free-flowing state. It's placed in electrolytic cells where it's reduced to chlorine, a by-product, and molten sodium, the ingredient for high octane gas.

Equipment designed for high heat and corrosion resistance wears better and lasts years longer when it's built with Stainless Steel. Specify Stainless Steel for your plant equipment. And if you want service-tested quality, specify USS Stainless Steel. *USS is a registered trademark*

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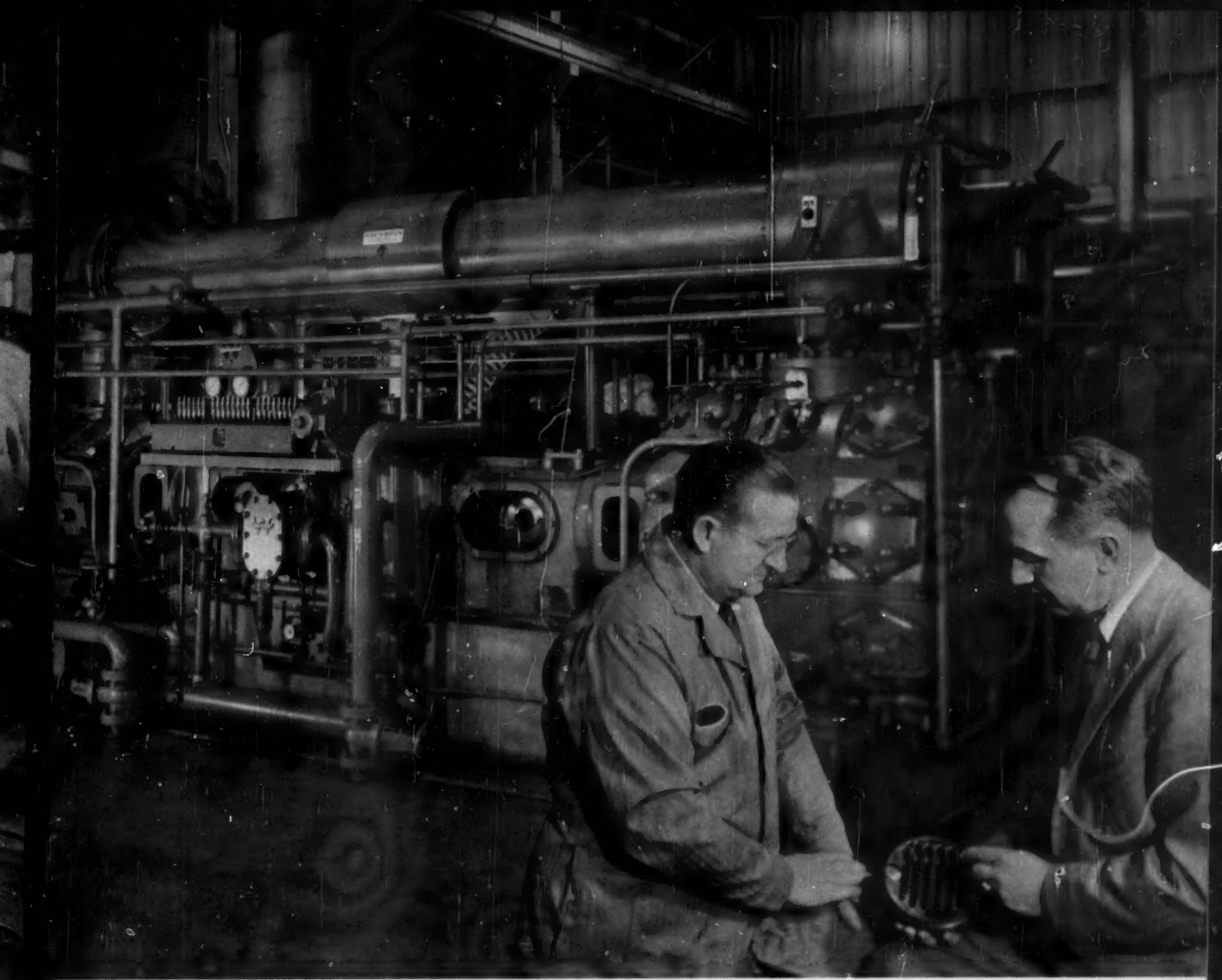
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

USS United States Steel



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*REG. U.S. PAT. OFF.

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2. Compressor Performance Characteristics

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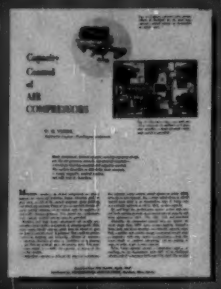


4. Capacity Control

5. Compressor Lubrication

6. Compressed Air Piping

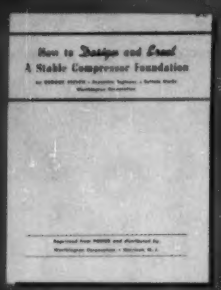
7. Compressor and Engine Foundations

8. Compressor Maintenance Clinic

9. Accessories and Protective Devices

10. Compressed Air for Ford's Cleveland Foundry

11. Picking Compressors for Air Soot Blowing



12. How to Erect a Stable Compressor Foundation

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WORTHINGTON

Chemical Engineering

Developments

Automatic pilot system cuts man-hours 90% 78

Though operators can control small pilot operations with relative ease, Cal Research is turning to automatic control for relief from high cost on long test runs.

Processors come up with their own new instruments . . 80

Faced with so many new products, processes and more stringent processing conditions—which old instruments can't handle—processors develop new instrumentation.

Flexible butadiene-avgas unit 84

Texas Butadiene & Chemical's butadiene-avgas plant has an extra built-in versatility that design engineers hadn't counted on and an interesting new product as well.

Linear polyethylene film: Now commercially available 88

Film is said to possess a unique mixture of properties: high surface gloss, stiffness, built-in tear-tape feature, crystal-like clarity and wide temperature tolerance.

Process equipment headliners 92

Powder densifier that reduces packaging costs. . . . New packless expansion joints. . . . High-efficiency rotary compressors. . . . New type of multiwall bag allows varied capacity.

In the plastics market: The race grows hotter 98

All along, plastics have been eyed mainly for specialty products. Now, though, they're looming large as basic materials for many big structural projects.

Coming soon: Column boosts HNO_3 output

A combined oxidation-absorption column gives Etablissements Kuhlmann's 200-ton/day nitric acid plant a record-breaking 98% over-all yield while turning out 70% acid.

JULY 14, 1958

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Plus factory trained engineers & technicians to assist you in selecting the types best suited to your needs*

There are more than 17,000 items in the Crouse-Hinds line of Condulet® and floodlighting equipment. Each is designed with some specific advantage or quality that makes it best suited for a particular application.

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Their job is to confer with the users of Crouse-Hinds equipment and to point out the reasons why certain Condulet equipment or floodlights are better suited for a particular job than others. With a broad grounding in the details of the National Electrical Code and a trained alertness for spotting explosion hazards in unsuspected places, they make a consulting or factory-engineer's job less onerous.

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DEVELOPMENTS . . .

JULY 14, 1958

Chementator

C. H. CHILTON

New trend in cracking catalysts is combination of natural and synthetic minerals. Two leading makers of straight synthetics now offer mixed products, acknowledging greater resistance to contamination showed by natural materials.

Russian engineers aim to recover useful energy when pipeline gas is depressurized for city distribution. Experimental installation near Kiev consists of turbines and heat exchangers for producing power and refrigeration.

CPI corporation lawyers worked overtime last month: Houdry Process Corp. seeks judgment against Commonwealth Oil for unpaid process royalties; Atomic Laboratories is suing Barnebey-Cheney, Carbon Wool Corp. and W. F. Abbott in connection with sales of carbon wool; and Farris Engineering charges Manning, Maxwell & Moore with patent infringement in design of safety relief valves.

Coming: Low-cost nuclear steam

Competitive electrical power from the atom may be many years away in the U.S. But three U.S. companies paint a much more optimistic economic picture for nuclear process heat.

Michigan Chemical Corp., facing the need for converting its oil-fired boilers at St. Louis, Mich., to coal at a cost of $1.5 million, is convinced that nuclear-based steam can be generated at a low-enough cost to justify the extra investment in a pressurized-water nuclear reactor. Martin Co. (to supply reactor and fuel elements) and H. K. Ferguson Co. (to design and build the plant) back up MCC's cost estimates.

Proposed 45,000-tkw., $2.5-million reactor would generate 150,000 lb./hr. of 150-psi. steam, using 3-4% enriched, aluminum-clad fuel elements. Estimated steam cost is 70¢/1,000 lb., based on 8,000 hr./yr. operation. But MCC figures on something less than full-load operation, anticipates 80¢ steam as a result. Company now pays about 90¢ for steam from an oil-fired package boiler.

Michigan Chemical is going to ask AEC to finance the plant. If AEC turns the proposal down, MCC intends to "exhaust every possible means" of rounding up the capital. Company is solidly sold on the project, feels it will pay out the investment in a "few" years from savings in cost of steam.

Count out the long countdown

Prepackaged, high-energy liquid monopropellants may be the answer to our vital need for ready-to-fire, liquid-fueled, long-range missiles.

Wyandotte Chemical reports substantial progress towards this goal. The firm already has under test variations of a system involving storable single fluids that outperform currently used liquid bipropellants and solids. Other companies doing research in this field

(Continued on page 74)

From atmospheric pressure to one-half micron...

Thin-Film processing techniques acquire a new dimension with the RODNEY HUNT Vacu-Film* Processor

Rodney Hunt now offers you a full line of thin-film processing equipment for high vacuum applications as well as in low vacuum and atmosphere ranges. For the first time you can secure, from one source, unbiased application and design engineering assistance leading to the proper and most economical solution to your chemical processing problem.

For many years the Rodney Hunt Turba-Film Processor has found wide application throughout the chemical process industries in atmospheric and low vacuum ranges. A large number of installations have demonstrated conclusively the superiority of this unit in processing organic and inorganic chemicals, pharmaceuticals, latices, petroleum residues, solvents, food concentrates, vitamins and many other products.

Now, with the introduction of the Vacu-Film Processor, Rodney Hunt extends the range of thin-film processing into high vacuum... to one-half micron.

Vacu-Film Processors utilize the tested and proved mechanically aided, accelerated thin-film principle perfected by Rodney Hunt. It assures retention of quality in the production of delicate and sensitive compounds as well as for processes which take advantage of the extraordinary behavior of organic molecules in high vacuum.

This new unit greatly reduces the thermal problem associated with processing high molecular weight materials. Organic materials with molecular weights up to 1250 can now be processed easily and economically. Installations presently in operation have delivered higher, purer yields than ever before possible in processes ranging from wax recovery to complex production of tranquilizer drugs.

Test results obtained from pilot size Vacu-Film and Turba-Film Processors can be readily extrapolated to production size units. Rodney Hunt maintains a fully equipped laboratory and pilot plant to assist you in your research, experimental, developmental and test projects. Laboratory and pilot plant units are also available for process evaluation in your own plant.

Rodney Hunt will welcome the opportunity to work with you in solving your process problems utilizing its extensive engineering, laboratory and pilot plant facilities. Please address your inquiry to the Rodney Hunt Process Equipment Division with details of your requirements.

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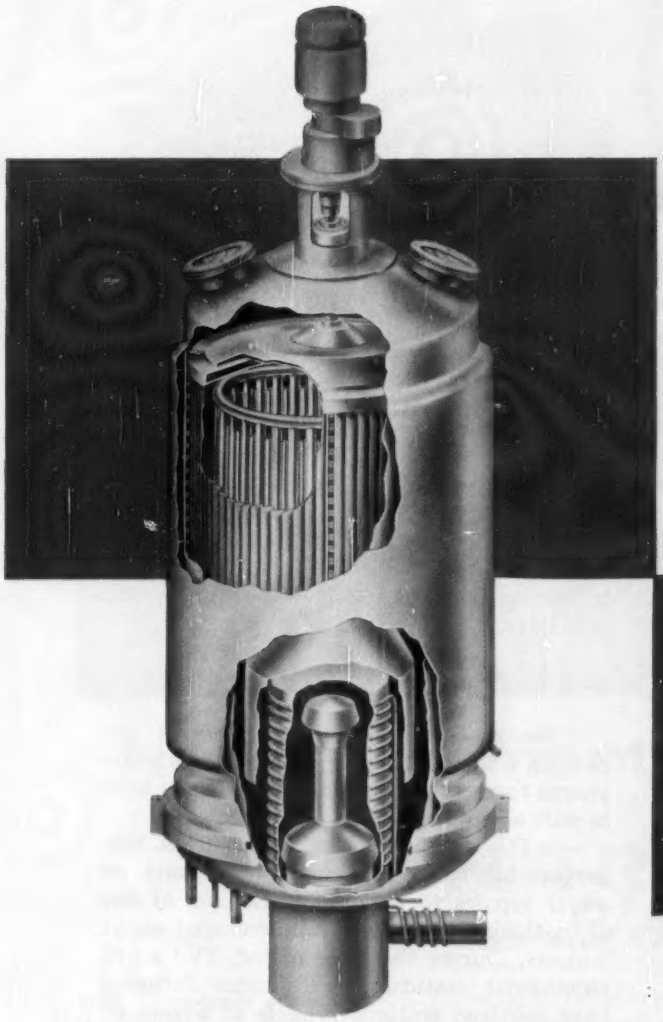
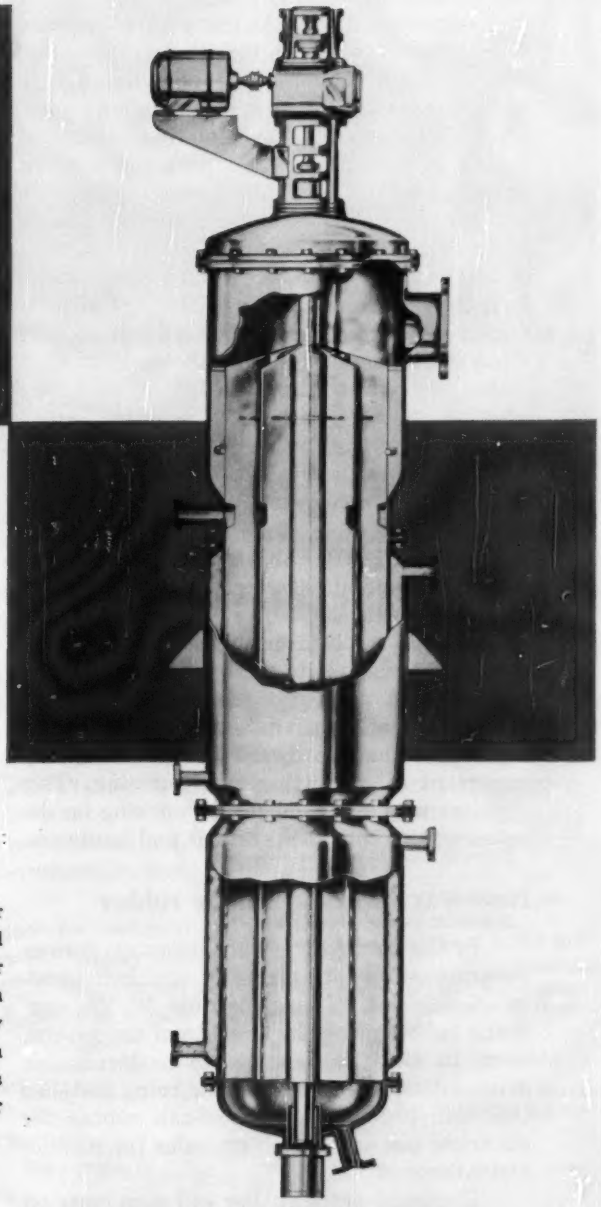
PROCESS EQUIPMENT DIVISION 37 VALE ST., ORANGE, MASS.

SERVING THE PROCESS INDUSTRIES WITH EQUIPMENT

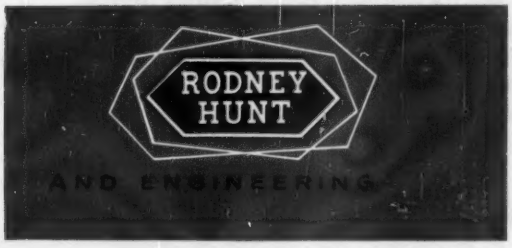


THE RODNEY HUNT VACU-FILM PROCESSOR has an alloy steel shell enclosing the rotor, shaft with wiper assembly, oil diffusion pump, oil seal, vertical condenser and entrainment separator. The alloy steel condenser is finned for efficient heat transfer and is water-cooled or refrigerated with circulating cooling fluid. Distillate and residue are separately discharged by oil-sealed positive pressure pumps. High vacuum is produced by conventional series coupling of high-speed gas ballast mechanical pumps and oil diffusion and oil ejector pumps.

* *Vacu-Film is a trade name of the Rodney Hunt Machine Co. Prior to June 1, 1958, this unit was manufactured under the name "ASCO" Rota Film Still.*



THE RODNEY HUNT TURBA-FILM PROCESSOR consists of a series of rotor blades operating within a thermal section and a separating section—all fabricated of alloy steel. Clearance between the rotor blade edges and the thermal section wall is exactly fixed to assure precise control of the film thickness. Vapor or gases pass upward through the thermal section to the separator from which entrained material is recycled to the thermal section. Steam, Dowtherm or other heating media is distributed in two or more compartments of the thermal section to assure a uniform temperature at the walls.



include Stauffer, Food Machinery, Aerojet-General and Phillips Petroleum.

Instant availability of solid-fueled missiles—contrasted with the many minutes, even hours, needed to launch today's large, complicated liquid-fueled missiles—puts liquid fuel systems at a disadvantage for defense purposes. What makes this situation especially galling is that liquid fuels pack much more energy than the best solid fuels.

Wyandotte's goal under a Navy research contract is "Fuel X" with a specific impulse of 300 sec. It would be storable over wider temperature ranges than solid propellants. Starting the engine would be simplicity itself; a gas generator would push the fuel out of a sealed tank into the combustion chamber, where it would ignite.

Chemical identity of this fuel has not been released. However, an Air Force spokesman recently nominated as liquid fuels most likely to be storable the combinations of nitric acid with UDMH (unsymmetrical dimethyl hydrazine) and nitrogen tetroxide with hydrazine or UDMH.

A still-unsolved problem facing Wyandotte researchers is to establish the conditions under which detonation cannot occur. This involves use of additives, but Wyandotte engineers say that hardware design is equally important in permitting safe handling. This explains why the company is working on development of both fuel systems and hardware.

New way to dry synthetic rubber

In the hands of private industry, former government facilities rapidly win individuality. Goodrich-Gulf's big Institute, W. Va., synthetic rubber plant, acquired from the government in 1956, is capping its modernization drive with new equipment now being installed that will provide a new low-ash rubber for electrical use and crumb granules for mastics and adhesives.

Electrical-grade rubber will soon come off a new 8,000-lb./hr. extruder-dryer, first big commercial unit of its type. Within minutes, machine reduces crumb moisture from over 50% to less than ½%.

In this unit, a conical feed screw, tapering from 24 down to 12 in. dia., squeezes the wet crumb under tons of pressure to reduce its moisture content down to 8-12%. Tapered screw discharges rubber through a restriction into another screw chamber, where remaining moisture flashes from the hot, worked rubber at 20-30 mm. Hg. Discharge screw extrudes dry rubber through spaghetti die.

Removal of most of the water by squeezing carries away soluble salts, thus lowering ash content. Other features: Dryer can change from one type of product to another with little cleaning; maintenance is much less than for older conveyor-dryer.

New crumb facilities replace makeshift equipment first used to introduce new product. Crumb drops from conventional conveyor-dryer through disintegrator, which reduces it to ⅛-$\frac{1}{16}$-in. size, then spews it out on a shaking cooler-conveyor. Automatic proportioning equipment carefully controls addition of powder to crumb before disintegration and after cooling to keep particles from sticking together. Automatic equipment weighs and packs granules in boxes.

Rotating furnace boasts long life

Electric-furnace engineers looking for data on ultimate life of TVA's rotating phosphorus furnace at Wilson Dam, Ala., may have to wait a long time.

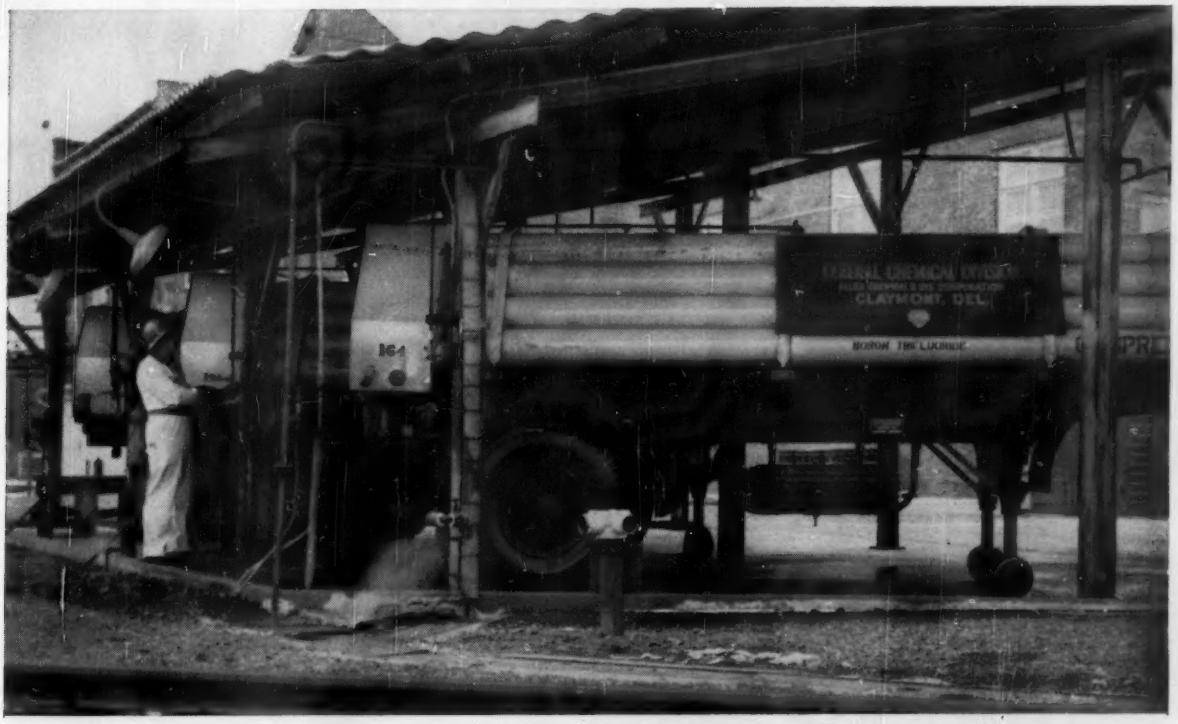
In 7½ years' operation, reports TVA, this furnace has had no hot spots, no tapouts, no major repairs to the lining. Erosion of the 41-in.-thick carbon floor has averaged about 1 in./yr. During the same period, TVA's five rectangular stationary phosphorus furnaces have required major overhauls at a rate of once every three years, and hot spots have occurred frequently.

In the rotating furnace, the roof, through which the electrodes are suspended, is fixed, while the circular crucible and its contents rotate at the almost imperceptible rate of 1 rev. per 50-200 hr. When the furnace was put on line in October 1950 (*Chem. Eng.*, July 1951, pp. 108-111, and Sept. 1953, pp. 201-204), certain operating advantages were soon demonstrated:

- Power consumption per unit of product was 16% lower than that of the stationary furnaces.
- Capacity per sq. ft. of hearth area was higher.
- Furnace could handle a high proportion of fines in the charge.

Major question left unanswered was life of lining. It's still unanswered, but TVA engi-

(Continued on page 76)



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With large-scale production . . . Baker & Adamson has long been the leader in production of BF_3 gas—shipping this versatile catalyst in large trailer trucks like those you see being loaded above. B&A pioneered this method of shipment and today has a fleet of these trucks always on the road, serving the needs of the process industries.

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Boron Fluoride Phenol Complex
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Boron Fluoride Ethyl "Cellosolve" Complex
Boron Fluoride Hexamethylenetetramine Complex
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neers have long since abandoned their death watch.

Gas sterilization gets plant job

Ethylene oxide sterilization as a production-line technique takes a big step forward in Pfizer's new biologicals center at Terre Haute, Ind.

In manufacture of vaccines and other heat-sensitive materials, sterilization by either steam or dry heat would cause rapid deterioration. Pfizer gets around this by exposing such materials to ethylene oxide vapor at room temperature for periods of 2 to 4 hr. in special autoclaves. Atmosphere in the autoclaves is actually a patented, nonflammable mixture of ethylene oxide (11%) and a fluorinated hydrocarbon (89%). This mixture is distributed in disposable aerosol cans under the trade name Cryoxcide by American Sterilizer Co.

Each of the two autoclaves in the Pfizer plant is on automatic cycle control. The operator charges the material to be sterilized; everything else is automatic, including dispensing of the gas mixture into the autoclave from as many as six aerosol cans.

Ethylene oxide has also found use as agent for sterilizing hospital rooms and bacteriological laboratories (*Chementator*, Mar. 24, p. 60).

Low temperature minimizes corrosion

Chemical engineers looking for the optimum way to treat waste pickle liquor now have another process to ponder.

First commercial installation of the Belle Fons process will soon be running at Hanlon-Gregory Galvanizing Co., Pittsburgh. Process is being made available by Pantech Engineers, Oil City, Pa., through Salem-Brosius, Inc., Pittsburgh.

The new $100,000 unit is designed to handle 3 gpm. of waste liquor. Although this capacity is rather small compared with the potential load from a big steel mill, it is three times that of the Ruthner process demonstration plant at Niles, Ohio, sponsored by a group of large steel companies (*Chementator*, June 30, p. 52). Salem-Brosius expects the Hanlon-Gregory unit, therefore, to yield reliable data from which larger plants may be designed with confidence.

The Belle Fons process consists essentially of evaporation of water from spent liquor, addition of fresh acid to crystallize most of the ferrous sulfate content and separation of the solids from the regenerated acid. In concept it strongly resembles the Koppers-Zahn process (*Chem. Eng.*, Aug. 1957, pp. 168-170).

Major point of difference is that the Zahn process uses a spray evaporator heated with combustion gases at atmospheric pressure, whereas Belle Fons conducts the evaporation under vacuum (2 psia.), using a falling-film evaporator and vapor recompression. Vapor recompression may be done with either a steam ejector (small plants) or a mechanical compressor (large plants), says Salem-Brosius. Large plants may find it economical to roast the waste ferrous sulfate in order to recover iron and sulfuric acid values.

Vacuum evaporation at only 130 F. makes it practical to build the evaporator of Alloy 20 instead of more-expensive materials. And vapor recompression keeps evaporator surface at a minimum, besides offering steam economy.

Operability of the process, however, will depend upon thorough removal of acid entrainment from the vapor. Salem-Brosius is banking on a Yorkmesh demister to do this job.

Cheaper titanium valves on the way

Recently improved techniques for turning out titanium castings portend lower prices for titanium valves—prices within 50% of comparable stainless steel valves. This optimistic outlook is offered by Stephen Shelton of Oregon Metallurgical Co., Albany, Ore.

Ormet is now using low-cost rammed graphite molds instead of expensive machined graphite molds for casting titanium. The rammed mold is made from powdered graphite and a special binder put out by Du Pont. Formerly a solid block of graphite had to be machined out to make a mold.

Machining of the valve parts still represents a sizeable cost, points out Shelton. But as machine shops become more accustomed to handling titanium, these costs may drop also. A typical 2-in. titanium globe valve today costs over $250; Shelton looks for prices well under $200 within a year.

The Albany firm, a pioneer producer of cast titanium equipment, is currently making cast titanium valve bodies for Freeport Sulphur's new nickel processing plants.

For more on DEVELOPMENTS.....78

Flash! Zirconium licks corrosion for control valves in chlorine service

Zirconium stems in process control valves are now being used in liquid chlorine service to eliminate costly downtime and maintenance expense caused by corrosion of conventional materials. Zirconium has demonstrated from 4 to 20 times longer life than type 316 stainless steel, and has proved superior to titanium and the high nickel and super alloys.

Engineers at Columbia-Southern Chemical Corporation, alert to corrosion-resistant possibilities of zirconium, tested it in actual operations for over two years.

Columbia-Southern has now standardized on zirconium stems, flanged packing glands, and hold-down nuts and bolts for all control valves in chlorine service.

Look at corrosion with zirconium in mind. Zirconium offers you the same opportunity to combat corrosion. Zirconium is now available in quantity and Columbia-National, through its technical service facilities and resources, will help you achieve economies in your processing operations by using zirconium to solve specific corrosion problems. Write for bulletin on properties and uses.

Valve stem above, of conventional stainless steel, failed after only six months, causing expensive downtime and maintenance.

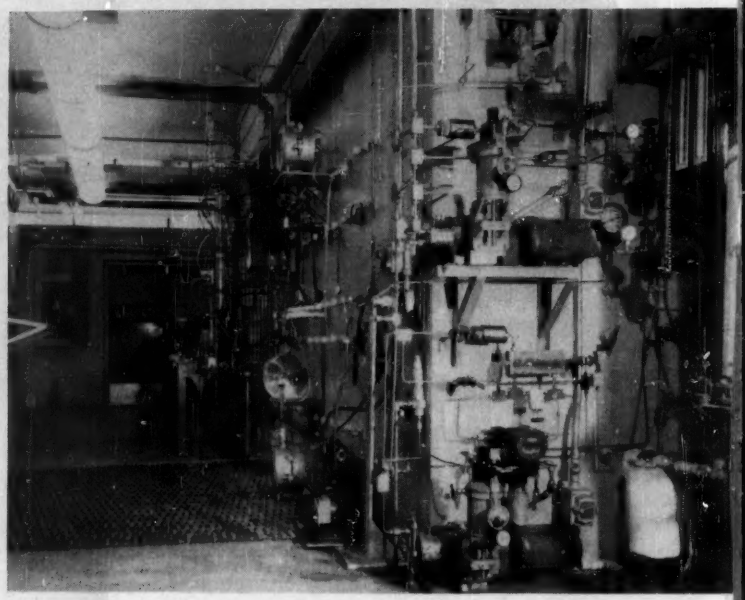
This control valve with a zirconium stem continues to operate dependably after two years of service at the Columbia-Southern Plant at Natrium, West Virginia.

Columbia-National Corporation

Jointly owned by National Research Corporation and Columbia-Southern Chemical Corporation

DEPT. CS-D—70 MEMORIAL DRIVE, CAMBRIDGE 42, MASS.

NEW METALS FOR INDUSTRY *n*



Automatic controls (above) lower operating cost for Stancal's 1 gal. per day pilot plant (right).

Full Process Control Wins Pilot-Scale Role

Even though operators can control small pilot operations with relative ease, California Research Corp.,* Richmond, Calif., is turning to automatic control for relief from high cost on long test runs.

Since early this year, CalResearch has operated a 1-gal./day, continuous-flow reactor system under automatic control that reduces operating manhours more than 90%, gives better data and faster results. Duplicating processes such as hydrofining, hydrogenation and catalytic reforming, pilot system is believed to be first of its kind to use monitored operation.

▶**More Long Runs** — CalResearch's willingness to hang automatic control on such a small plant grows out of rising need for extended runs to check out the long-range effects of catalysts, feed stocks, processing severities, etc., in a typical refinery situation.

Conducted in ordinary pilot plants, these tests are exceedingly expensive. But, CalResearch believes that it can hold down these costs by increasing instrument's share of plant investment from 15-20% to 60%, despite three- or four-fold rise in total outlay.

▶**Size No Barrier**—With a 1-gal./day throughput rating, CalResearch's pilot plant would seem to qualify as a bench-scale or miniature unit. In truth, however, it is a continuous-flow, high-pressure system that operates under conditions identical to those found in a commercial, high-pressure plant.

Working at temperatures up to 1,100 F. and pressures as high as 3,000 psi., system can handle any continuous-flow reaction that can be carried out in stainless steel.

As a research tool, plant can provide data on any number of new processes. On processes already scaled up to production size, it furnishes kinetic data.

From the standpoint of hardware, system provides process environments for evaluation of instruments and materials of construction for full-scale use.

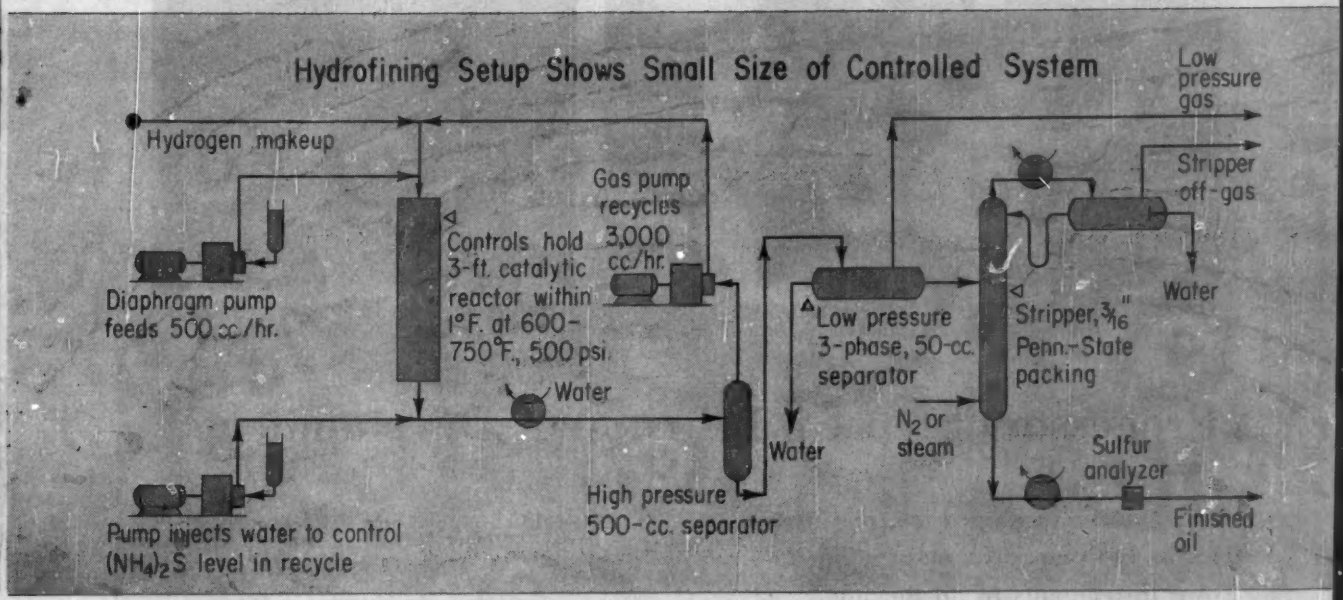
▶**Check Out Catalyst**—A recently completed 700-hr. life test on Oronite hydrogenation catalyst illustrates how the system operates and what it proves.

Test was run to substantiate estimates of catalyst's life on hydrodesulfurization of a particular gas-oil feed stock with impure hydrogen. Throughout the test, plant produced specification product and showed that catalyst activity did not decline measurably.

During the test, operation was faultless with reliability superior to that of a manually operated plant. And whenever operating conditions were changed, system reached equilibrium within 3 hr., some 5 to 9 hr. less than required for manually controlled pilot units.

▶**Standard Practice**—For this test, the plant setup and opera-

* Standard Oil Co. of California's research operating company.


Hydrofining Setup Shows Small Size of Controlled System
Hydrogen makeup
Diaphragm pump feeds 500 cc/hr.
Controls hold 3-ft. catalytic reactor within 1°F. at 600-750°F., 500 psi
Gas pump recycles 3,000 cc/hr.
Water
Pump injects water to control $(NH_4)_2S$ level in recycle
Water
High pressure 500-cc. separator
Low pressure 3-phase, 50-cc. separator
N_2 or steam
Stripper, 3/16" Penn.-State packing
Low pressure gas
Stripper off-gas
Water
Sulfur analyzer
Finished oil

tion conformed to commercial hydrodesulfurization practice (see flowsheet).

Pump transfers feed from a calibrated reservoir into system where it mixes with recycle and makeup hydrogen. Entering the reactor, stream passes first through preheater then into catalyst bed.

Reactor effluent mixes with injected water to prevent formation of ammonium sulfide which could plug recycle line. After cooling, mixture passes through high-pressure (500 psi.) separator which splits out non-condensable gas containing 40-95% hydrogen for recycle back to reactor.

Liquid product and water are depressured into an atmospheric separator which discharges low-pressure gas, raw product oil and a waste water stream.

Oil passes to column packed with 3/16-in. Penn. State packing where nitrogen or steam removes dissolved H_2S and light hydrocarbons. Stripped product passes through a cooler and sulfur analyzer on its way to storage.

▶**More on Equipment**—Much of the equipment in this plant was designed at CalResearch.

Liquid feed enters the system through a CalResearch-designed, 500-cc./hr., diaphragm pump constructed of Type 316 stainless steel. Gas recycle pump of same material moves about 3,000 cc./hr. of 500-psi. gas.

Reactor, of Types 321 and 347 stainless steel, measures about 3 ft. long, divided equally into preheater, catalyst bed and afterheater. Catalyst bed has capacity for 75-150 cc.

Electrically heated preheater, inserted in top of reactor tube, raises incoming feed to reaction temperature as it channels down a spiral, square-grooved path.

High-pressure separator is a 500-cc. Type 347 stainless-steel pot. For the low-pressure separation of water, oil and gas, plant relies on a complex, glass, tubular, 50-cc. vessel.

▶**Where Control Enters**—Feed rate to the system is sensed by capillary flow elements designed by CalResearch. Acting on these measurements, controller sets pump flow rate.

Makeup hydrogen enters through a flow recorder and downstream pressure regulator to maintain desired system pressure.

Outstanding control feature of the plant is ability to hold reactor temperature within 1 deg. F., no mean feat at 600-750 F. Trick in holding such close control lies with low heat capacity of system. Instead of relying on a hot mass, such as a furnace, to hold an even temperature, reactor uses fast-responding electrical radiant heaters.

A stream of cooling air flows between the heaters and reactor. Through pneumatic controls, the system uses the signal from fast-response, pencil-type thermocouples to balance heat removal with sufficient heater input to hold temperature at the control point. Varying less than one degree, the temperature follows a sinusoidal curve, rather than the common sawtooth.

Sulfur content is analyzed continuously by a new stream analyzer based on absorption of x-rays from radioactive iron. Gas-liquid partition chromatography and similar stream analyzers could be used, according to process needs.

VISCOMETER continuously records data automatically corrected to 25 C. Instrument designed by Dow for high polymer process.

DISK of Lucite rotated in process stream at 5 rpm. is the heart of the continuous viscometer.

Processors Step Up Instrument Developments

Faced with process conditions that existing instruments can't measure, many companies now develop their own instruments to do the job.

New products, new processes, more stringent processing conditions—in ever-mounting profusion these factors are quickening the demand for new types of instruments to keep tabs on what's happening.

To keep pace, many chemical and petroleum companies now design instruments because, for a given job, there is no commercially available model. And finally having solved their immediate problem, they frequently license them to instrument manufacturers for general sale.*

Several instruments developed recently indicate how a few of these companies have upgraded their process control:

• Dow Chemical Co. has installed several new temperature-compensated, recording-controlling viscometers (1,000-4,000 poises) at its new Zefran nitrile-alloy plant, Lee Hall, Va.

• Shell Development Co. has tested a new continuous initial-boiling-point recorder for hydrocarbons boiling at 200-400 F.

• Standard Oil Co. of Indiana now uses a continuous flash-point tester and an automatic batch end-point tester to maximize production of heater oil.

• Phillips Petroleum Co. will use a peak reader that makes possible the use of gas chromatography for automatic, closed-loop control of a fractionator (*Chem. Eng.*, May 19, 1958, p. 57).

Actually, these are but the most recent instances of what these particular companies have done. All have developed a number of earlier instruments.

▶How Development Starts—Dow's experience with Zefran shows why a company may undertake instrument development.

When Dow was putting together its process for producing Zefran, it faced the problem of continuously measuring a process stream of high polymer having 1,000-4,000-poise viscosity. And to further complicate the picture, temperature coefficient of viscosity varies 5%/deg.

To measure this material well with existing instruments, Dow would have required very precise control of temperature in a small sample stream and around the sensing zone, or good temperature compensation. And the types of special elements called for would have increased maintenance considerably.

▶What Group Produced—Dow's instrument laboratory group at Pittsburg, Calif., under Project Leader Dr. Robert Crane overcame these obstacles with the viscometer pictured above. Covering a range from 0 to 4,000 poises on a linear scale, instrument compensates for temperature variations from 15 to 50 C.

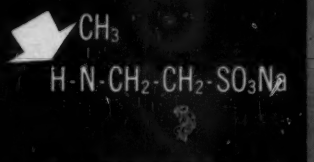
Design provides for operation at line pressures up to 150 psi. without shift in zero setting when pressure fluctuates. Rugged, reliable and easy to install, viscometer's principal shortcoming is a slight sensitivity to flow changes.

▶Inserts in Line—Instrument senses viscosity through drag on a 2-in. rotating Lucite disk inserted into a 3-in. Saran-lined pipe tee. Torque required to rotate the disk at a constant speed of 5 rpm. is measured through the thrust of a worm torque-transfer device on a strain gage.

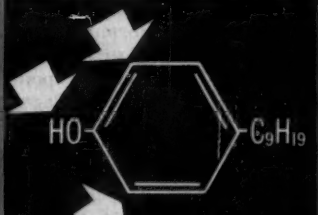
A null-balance potentiometer-type circuit measures the output of the strain gage. Voltage across the slide wire varies with any change in the temperature of the process stream so that the recorder always indicates viscosity corrected to 25 C. This automatic compensation is actu-

* Dow and Shell instruments are licensed for manufacture and sale by Hallikainen Instruments Co., Berkeley, Calif.; Standard Oil's by Precision Scientific Co., Chicago, Ill.

highly reactive bulk-produced intermediates



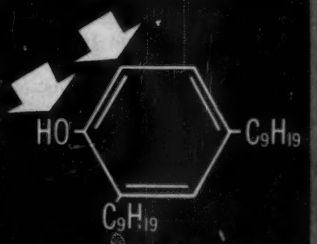
methyltaurine 22
methyltaurine 55



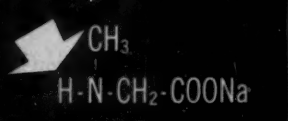
nonylphenol

for making

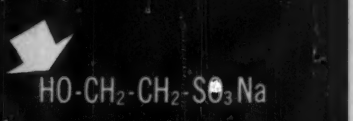
SURFACTANTS
VINYL STABILIZERS
LUBE-OIL ADDITIVES
DISINFECTANTS AND GERMICIDES
DIAZONIUM COMPOUNDS
PHARMACEUTICALS
RUBBER CHEMICALS
ORGANIC SOLVENTS
ANTIOXIDANTS
and other products



dinonylphenol



sarcosine SF-32



sodium isethionate

Profitable new products lie hidden where white arrows mark the sites of maximum reactivity. Reach for new markets by creating improved chemicals from these versatile bulk intermediates. Write for more information and technical literature today.

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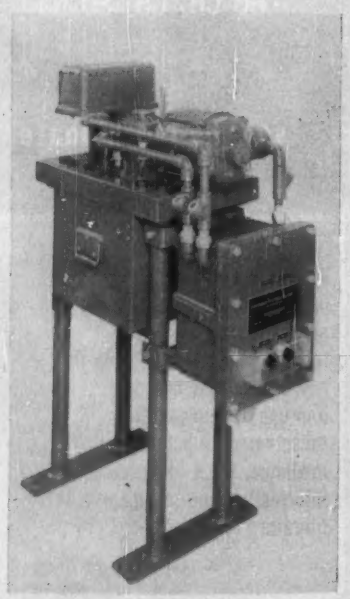
ated by thermistors positioned in the stream close to the rotating disk.

▶ **Another Tailor-Made** — Dow also operates several automatic colorimetric analyzers developed by its instrument group to detect 0-2 ppm. iron in electrolytic-caustic cell effluent.

At periodic intervals, instrument withdraws a sample and analyzes it by photoelectric comparison. Standard control features such as high alarms, proportional control, etc. can be obtained by selection of the most suitable recorder for use with the analyzer.

Ingenuity Builds Continuous Instruments . . .

COLORIMETER needs little attention as it automatically records Fe in caustic solution to help prevent an excess in the marketed product.



VISCOMETER, developed for use on oils and other petroleum products, continuously measures and records viscosity of process streams.

▶ **Match Lab Procedure**—Shell Development Co. has successfully operated for the past year a continuous recording instrument that provides a temperature indication on a continuous flow sample which is equal to the ASTM initial boiling point. Instrument serves as a monitor on specification materials such as technical solvents, gasoline fractions, naphtha and kerosene.

In duplicating the results provided by ASTM Method D-86, Shell had to incorporate the characteristic traits of this test. The ASTM initial boiling point temperature is reproducible, so that it is fine for control. But, the temperature is neither equal to an analytical distillation initial boiling point, nor, is it equal to the temperature of the first vapor to boil from the sample.

Therefore, when Shell designed its instrument, it had to provide a temperature indication that is distorted from the true vapor temperature to exactly the same degree as the ASTM determination.

▶ **Boost Heater Oil Output**—Desire to maximize production of heater oil during peak seasons led Standard Oil Co. of Indiana to develop its new continuous flash-point tester and batch end-point tester. Normally determined by tedious, expensive, time-consuming ASTM procedures, these values are the key to keeping the distillation range of the heater oil as broad as the specifications allow and the product fractionations as sharp as possible.

FLASH-POINT tester is automatic and gives a reading every 3 min. Its range is 85-180 F. and results agree closely with standard cup.

Through use of these new instruments, Standard controls the process much closer to produce more product and cut losses of off-specification material.

In keeping with their intimate knowledge of process and product, these various companies are demonstrating beyond a doubt that instrument development is really one integrated part of a company's process and product development.

Process Stretches Butyl's Life Span

U. S. Rubber Co. has unveiled its new vulcanizing process for butyl rubber that increases its useful life fourfold and markedly improves its temperature resistance. Process is already finding commercial use in production of such products as tire curing bags, steam hose, conveyor belting and jet and rocket parts.

New process depends on vulcanizing with a phenol-formaldehyde resin (such as 2,6-dimethylol-4-hydrocarbyphenol or its condensation polymers) instead of with sulfur as discovered originally by Charles Goodyear and used by the rubber industry ever since. U. S. Rubber's new vulcanizing technique was described at the recent American Chemical Society meeting in Cincinnati, Ohio, by P. O. Tawney, J. R. Little and Paul Viohl.

Butyl rubber vulcanized with phenolic resin retains 70% of its tensile strength after aging for 16 days in circulating air at 300 F. Sulfur-vulcanized butyl, on the other hand, loses 50% of its tensile strength after only two days at 300 F.

Cost of the new vulcanizing process is comparable to conventional sulfur vulcanizing. However, firm is sticking with conventional process in applications where improved properties aren't needed rather than incur the expense of a changeover to a non-sulfur process.

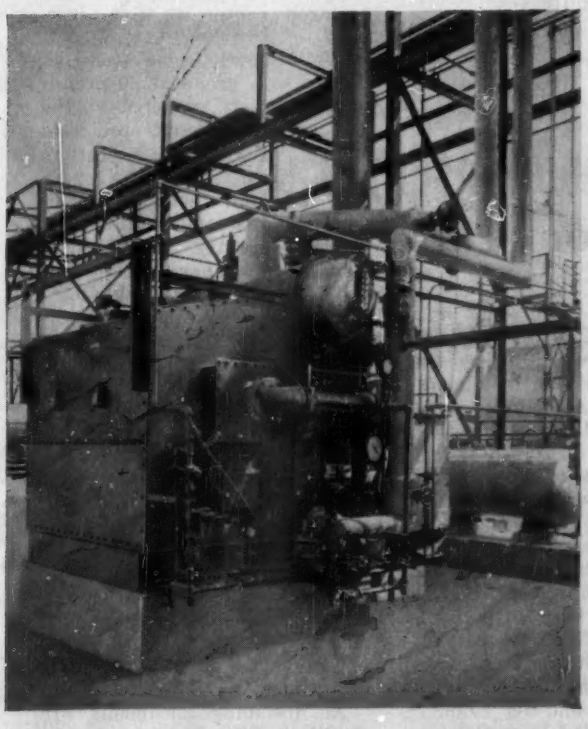
During the past 23 years

ONE large chemical company

has installed 54

FW VAPORIZERS

... with a total capacity of 310,619,000 Btu/hr



Typical outdoor installation of a 2,000,000 Btu/hr FW Vaporizer using Dowtherm.

REPEAT orders from satisfied customers account for the majority of Foster Wheeler's business in the process heating field. For example, one large chemical company has been using FW Vaporizers for 23 years. They now have installed 54 units with a combined capacity of 310,619,000 Btu/hr.

In this specialized process heating equipment, the importance of Foster Wheeler's quarter-century of *experience* cannot be overemphasized. FW Vaporizers using Dowtherm* have been supplied for over 600 installations in sizes ranging from 44,500 Btu/hr to 45,000,000 Btu/hr.

Based on this experience gained in hundreds of applications to different processes, FW analyzes your *entire process heating system* before recommending a design. FW then does the complete job — designs and builds the Vaporizer, installs it in your plant, puts it "on stream" and makes sure that everything functions at top efficiency.

For information on the equipment best suited to *your* process heating requirements, write to *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.*

*Reg. Trade Mark, Dow Chemical Co.

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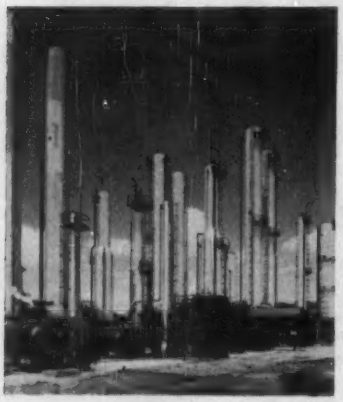
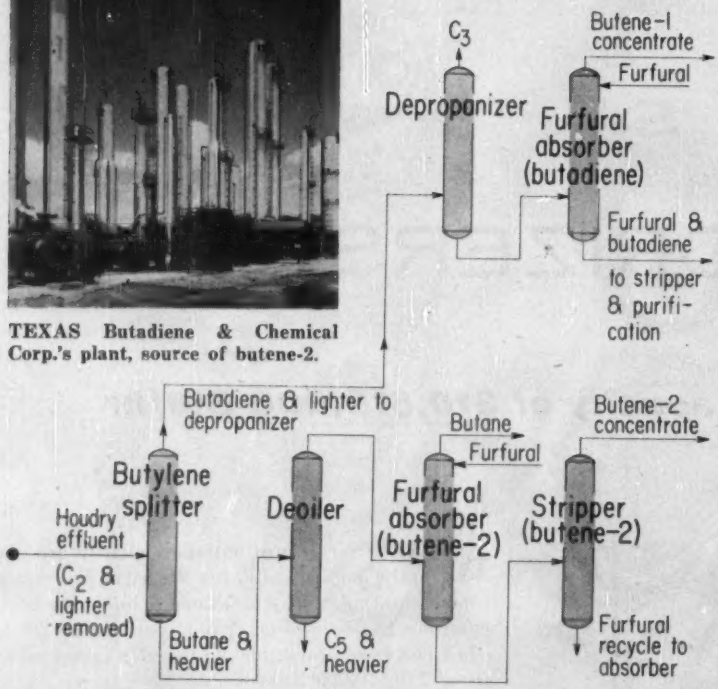
One Absorption Train Now Upgrades Butene-2



TEXAS Butadiene & Chemical Corp.'s plant, source of butene-2.



Plant Wins Butylene Isomers

Revamped process separates high-purity butylene streams.

Texas Butadiene & Chemical's butadiene-avgas plant at Channelview, Tex., has an extra built-in versatility that design engineers hadn't counted on. And an interesting new product, too: A high-purity concentrate of 2-butylene (74% 2-butylene, with no more than 2% 1-butylene).

The bonus showed up after the butane-based plant reached full capacity last year (*Chem. Eng.*, Oct. 1957, pp. 224-227). TB&C found it could handle full butadiene capacity in one of the twin extractive distillation circuits set up to contact furfural—via the Phillips process—with a feed containing butadiene and 1-butylene.

Plant engineers swung the other furfural absorption unit over to upgrade—to the current 74%—an impure 2-butylene-butane stream which alternatively had been sent to avgas alkylation facilities or recycled to mix with fresh feed to the Houdry butane-dehydrogenation reactors. (TB&C can produce a 96% 2-butylene cut by means of blocked-out operation.)

Texas Butadiene & Chemical plans to complement its butylene market picture with a 1-butylene concentrate. This product occurs normally in the 60% range of purity (with a maximum of 1% 2-butylene and 5% isobutylene) as overhead from the furfural extraction of butadiene and is recycled to the dehydrogenators or piped to alkylation. The company is already looking for ways to get the 1-butylene level up to better than 90%.

Up till now butylenes have been produced as mixed isomers from refinery cat cracking. Present processes for *n*-butylenes' chief end uses—butadiene and sec-butanol—can handle feeds of mixed isomers. But in other reactions a mixed feed may give a mixed product, difficult to rectify and containing an unmarketable component.

Thus, figures TB&C, a feed stock containing a single normal butylene isomer may "open up new avenues of approach to butylene chemistry."

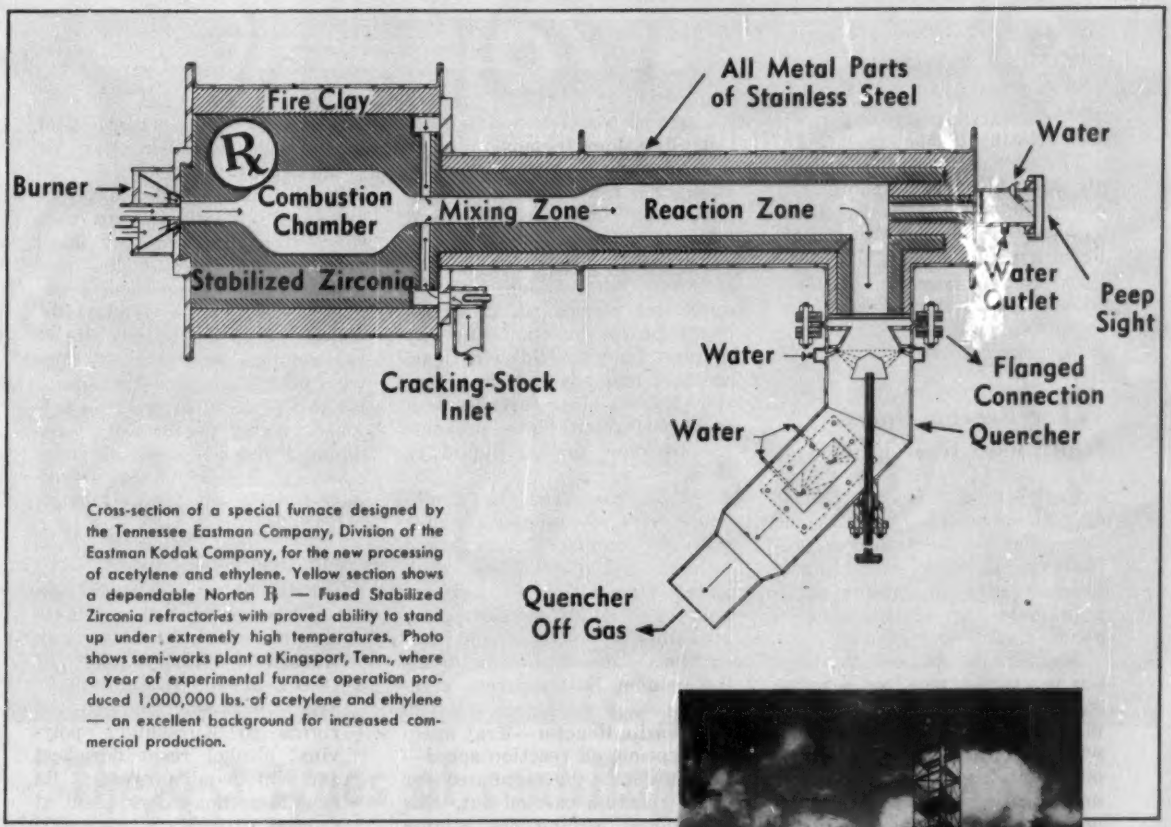
Page-to-Desk Flow of Data Hastened by IBM

Described by International Business Machines Corp. as a "breakthrough" in both information dissemination and retrieval, IBM's new "business intelligence system" was outlined recently at the opening of the firm's new $16-million plant and research center at San Jose, Calif.

IBM's development was described to a group of 80 prominent scientists gathered at the dedication to discuss problems of scientific communication. These scientists agreed to a man that adequate scientific communication is sadly lacking both in this country and abroad. Brought into sharp focus were the extensive abstracting facilities of the Russian scientific information institute—far bigger than its counterparts in the Western world.

As a partial answer to this need, H. P. Luhn, senior research engineer at IBM, claimed that IBM's new system can be set up with existing data-processing machines combined with communication facilities and input-output equipment. Key to system is automatic creation and updating of "action-point profiles" (a description of activities of either an individual or a group).

All incoming documents are introduced into machine, assigned serial numbers and reproduced on microfilm. Microfilm copy is transcribed on magnetic tape which is then put through an auto-abstracting and coding device. Information is then matched with each "action-point



Cross-section of a special furnace designed by the Tennessee Eastman Company, Division of the Eastman Kodak Company, for the new processing of acetylene and ethylene. Yellow section shows a dependable Norton Rx — Fused Stabilized Zirconia refractories with proved ability to stand up under extremely high temperatures. Photo shows semi-works plant at Kingsport, Tenn., where a year of experimental furnace operation produced 1,000,000 lbs. of acetylene and ethylene — an excellent background for increased commercial production.

New Tennessee Eastman Process uses NORTON Zirconia Refractories

Zirconia lining permits high, uniform heat flux for improved production of acetylene and ethylene.

Heart of Tennessee Eastman Company's advancement in processing acetylene and ethylene is a newly designed furnace. Here, saturated hydrocarbons are decomposed in hot combustion gases. High temperature heat must be supplied rapidly and uniformly. Since an endothermic reaction is involved, a zirconia lining was specified because of its ability to insulate at high temperatures and to conserve valuable heat. This furnace operation required refractories capable of withstanding continuous operation at temperatures in excess of 2,000°C.

Norton Fused Stabilized Zirconia was specified in special shapes for the inner courses of the combustion chamber, mixing zone and reaction zone. As a result, the structural stability and suitability of the furnace for continuous use was confirmed when the combustion chamber was found to be in excellent condition after 100 days of operation.

The development of Fused Stabilized Zirconia is a typical Norton aid in utilizing higher temperatures for greater efficiency and output. Norton was first to bring this valuable material out of the experimental stage. Now it is used in many forms for commercial production.

Investigate Norton Rx's — refractories *engineered and prescribed* to save time, work and money. See your Norton Representative or write to NORTON COMPANY, Refractories Division, 506 New Bond St., Worcester 6, Massachusetts.

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Engineered... Rx ...Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — BEHR-MANNING DIVISION Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

profile" so that everyone gets all data relating to his job.

Through a printing device on his desk, the "action-point" can get basic data such as serial number, heading and author. For further information, he can then dial a monitor (random access device) for abstracts or complete copies.

Tower Reactor Speeds Multiphase Reactions

Karl Ziegler, German chemist of low-pressure polyethylene fame, has just obtained a preliminary German patent on a tower reactor for gaining maximum yields in reactions between solids, liquids and gases.

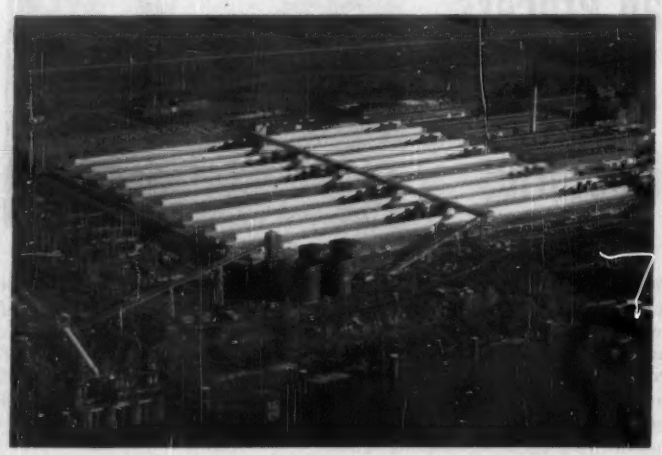
Main claim for new continuous reactor is optimized reaction speeds—thus in commercial applications one reactor may suffice where several were needed previously. And subsequent filtering or decanting to separate unreacted solids may be eliminated because of complete solids reaction. In design, the novel reactor is essentially a modified perforated-plate tower having liquid "upcomers" connecting each plate.

All streams feed into bottom of tower. For reactions between solids and liquids, an inert gas phase pushes reactants up the column; for gas-solids reactions, an inert liquid is used as a carrier. Gas cushions form beneath each perforated plate, preventing backflow of any liquid or solid.

Solids, dispersed in liquid phase, rise to successive plates through "upcomers" submerged beneath liquid level on each plate. Upcoming gas agitates liquid and solids on each plate providing thorough mixing; gas cushions also act as seals dividing column into separate reactors.

▶ **Versatile Reactor**—Tray spacing depends on reaction speed—distance must be calculated for every reaction carried out. Gas and liquid leaving the column are separated in a decanter and inert phase (either gas or liquid) can be recycled.

Ziegler has used this tower at pressures up to 200 atm. to react solids like aluminum and magnesium with liquid olefins and hydrogen, obtaining such products as aluminum trialkylates and Grignard compounds. Reaction columns were 10-16 ft. high with 5-10 plates and containing 0.3 to 1.6 cu. ft. of reaction volume; plate perforations are under 1 mm. Scaleup of these towers to commercial size should be relatively easy, says Ziegler.



Massive Al-Reduction Plant Swings On Stream

Ormet Corp., owned jointly by Olin Mathieson and Revere Copper & Brass, has started production at its new $110-million plant on the banks of the Ohio River near Clarington, Ohio. When in full production by end of year, plant's 180,000-ton/yr. output will make Ormet nation's fourth largest aluminum producer. Three major units in new facility are, left to right, electrical switchyard, pot-room buildings and carbon plant.

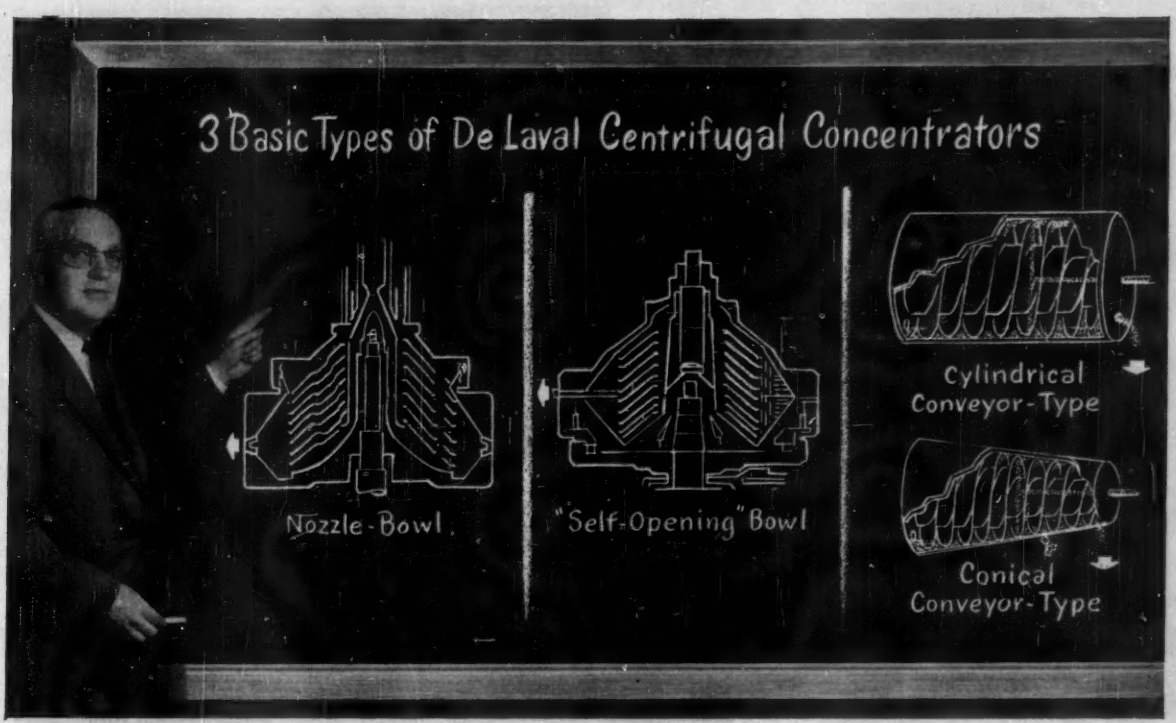
News Briefs

Synthetic fiber: Air Reduction Co. has acquired U. S. rights to vinylon fiber process from Kurashiki Rayon Co. of Osaka, Japan. In same package, Air Reduction acquired rights to Kurashiki's polyvinyl alcohol resin flowsheet and will install process at its new 20-million-lb./yr. plant at Calvert City, Ky.

Waste treatment: American Cyanamid has brought its $4.5-million biological waste treatment unit on stream at its Bound Brook, N. J., plant site. New unit will also provide secondary sewage treatment for nearby communities of Raritan, Somerville and Bridgewater.

Research & development: Union Carbide's president, Morse G. Dial, says that Carbide has spent over $60 million in the past five years expanding research and development facilities. Total R&D budget in 1957 alone was $65 million and 1958 expenditures will remain at same level.

Desalted water: Government of Aruba in Netherlands Antilles has started up world's largest single unit for converting sea water to fresh water. The $10-million plant, engineered and built by Singmaster & Breyer, has 2.7-million-gal./day capacity—enough for island's 55,000 population and the American-owned, 440,000-bbl./day refinery of Lago Oil & Transport Co.



"These 3 types of centrifugal concentrators give you continuous concentration of solids,"

Fred Wheelwright, De Laval Separator Co.

The fast, continuous way to recover or concentrate a solid product from a slurry is by centrifugal force. Compared to slow, cumbersome batch-settlers, De Laval centrifugal concentrators give you high speed and continuous-flow processing. Furthermore, centrifugals take up only a fraction of the floor space required by settling tanks.

De Laval manufactures all three basic types of continuous centrifugal concentrators. So it's not painful for us to be completely objective when we're called on to recommend a particular machine for a given set of process data. Briefly, here's a general description of the three types:

Nozzle-bowl: As in all centrifuges, our nozzle-bowl centrifugals throw the solids to the outside, against the bowl. But instead of being held there, the solids are concentrated and discharged continuously through the specially designed nozzles built into the bowl wall. (See sketch)

The nozzle-bowl will handle any product in which the concentrated solids can be pumped. For extra-high concentration, the concentrate can be recirculated through the bowl. The nozzle-bowl successfully produces some concentrations as high as 40% by volume.

"Self-opening" bowl: This is something of a misnomer, because the "solids discharge aperture" (see sketch) is kept closed by hydraulic pressure until solids in the bowl are built up to a predetermined amount. Hydraulic pressure on the bowl is then relieved by automatic controls or manually, thus opening the bowl (while it is running at full speed) and ejecting the solids.

We apply this machine on liquids containing fibrous-type solids, where a high concentration is needed (up to 50% by volume). As opposed to the nozzle-bowl, this machine gives high concentration on products which break down or foam when recirculated.

Conveyor-type: There are really two types here . . . cylindrical and conical (see sketches). Both are used for concentration of crystalline-type solids. The conveyor screw rotates slower than the bowl but in the same direction. As the solids build up on the bowl, the conveyor carries them to the discharge ports.

The conical-type is best for solids which pack tightly and have a high angle of repose. The cylindrical-type is best for soft, plastic solids.

Experience generally enables us to dictate the type of machine best suited for a given application. But it is still a fact that you can't always predict how a material will behave when it's subjected to centrifugal force. This keeps us humble, and it also keeps our pilot plant busy. In our lab and pilot plant, we can simulate most process conditions and determine the most efficient way to get concentration.

If you'd care to send us the design criteria or process data on your concentration problems, we will give it careful analysis and submit objective recommendations. All in strictest confidence, of course. Or for literature on any of the machines I've described, just write on your letterhead (but say which type of machine you're interested in).

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New Polyethylene Films

Low Density

Free of haze, experimental film via extrusion-coating equipment.

Polyethylene film of unprecedented transparency and gloss has been made by U. S. I. via an unconventional processing technique believed to be commercially promising.

The production method, called casting, is accomplished on extrusion - coating equipment rather than standard film-extruding equipment. In the laboratory-production trials, Petrothene 205—density 0.924—was the resin used.

In the production of polyethylene films, lower-density resins generally provide superior toughness while higher-density materials render better clarity. Casting permits production of a film both tough and clear.

The casting technique does pose production problems regarding control in uniformity of gage. Users must take great care in choice of resin and adjustment of operating conditions to get adequate toughness as well as super clarity.

The new method is generally faster than conventional extrusion. Production costs appear equal, although the equipment needed for cast film is initially more expensive.—**U. S. Industrial Chemicals Co., New York, N. Y.** 88A

First Commercial Linear Film

Unique mixture of properties suits it for cellulosics, conventional poly markets.

First commercially available linear polyethylene film is said to offer a much-sought combination of such properties as stiffness, high surface gloss, a built-in tear tape feature, crystal-like clarity and ability to withstand a wide temperature range.

Called Conolex, it was developed by Continental Can Co. from linear resins of the type of Phillips Chemical's Marlex 50 polyethylene.

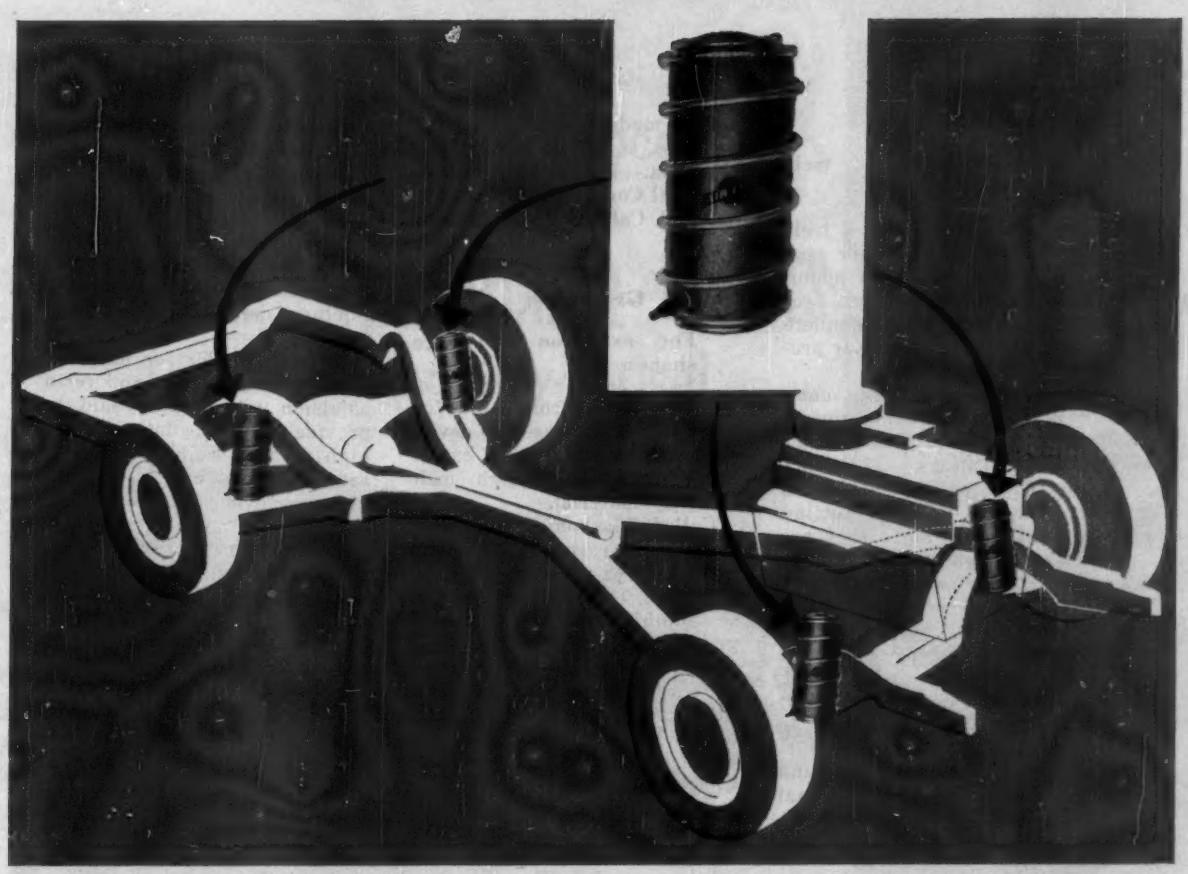
Like Dow's recently introduced styrene film (*Chem. Eng.*, June 30, 1958, p. 64), it is expected to compete for cellophane and cellulose acetate markets on the basis of lower cost and clarity (2% less clear than cellophane, with which styrene film is about on a par).

Unlike styrene film, it resists —100 F. to 250 F., is a barrier, rather than breathing, film, and it will heat-seal. Therefore, it can aim initially at a larger segment of the cellulosics market and it can also compete with conventional polyethylene.

Unlike conventional polyethylene, Conolex is strong and stiff enough to permit handling in high-speed, automatic push-through packaging machinery. Its clarity, cost and temperature resistance are also on the credit side here. For a given price, enough Conolex can be bought to cover half again as much area as conventional polyethylene.

Conventional printing methods may be applied to the film which is available in any and every color. The material has an extremely low permeability level for acids and oils, and high tensile strength.

Being made from linear resins, Conolex is capable of being extruded in such a way that the molecules are oriented in a single direction. A straight tear can be made in this direction only. The conventional cellophane tear tape found on cigarette and cracker packages could be replaced by a printed line to indicate proper tear direction on the new film.—**Continental Can Co., New York, N. Y.** 88B



Pneumatic Spring Controls are made with Enjay Butyl to provide quieter, softer cushioning in automobiles.

ENJAY BUTYL

actually lets you ride on air!

Enjay Butyl Rubber is used by the Armstrong Rubber Company, West Haven, Connecticut, in the production of Air Lift Pneumatic Spring Controls for the Air Lift Company, Lansing, Michigan. Butyl Air Lift units are inserted between leaf spring and frame to support overloads and cushion all moving parts of suspension. Inflatable to meet load requirements, these units protect vehicles–provide a smoother, safer ride.

Each week the Armstrong Rubber Company turns out thousands of Air Lift units made from Enjay Butyl Rubber. They chose Enjay Butyl because of its superior air retention and resistance to aging. Since tough, weatherproof Butyl is low in cost, it may be the answer to lower production costs for you. For complete information and expert technical assistance, call or write the Enjay Company.

ENJAY BUTYL

Enjay Butyl is the greatest rubber value in the world. It's the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

Pioneer in Petrochemicals

ENJAY

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

Adhesives

Granular form hot melt products.

New granular form hot melt adhesives are said to offer ease of application, lower per pound cost, adaptability to high production speeds and complete elimination of the need for premelt equipment.

Especially suited to bag seaming and straight line gluing, they are also adaptable to other gluing operations. The "hot melts" have been described as the ultimate in high setting speed adhesives since they are 100% solids and do not require a porous surface to carry off a fluid vehicle or solvent.

They display the reversible feature of softening with heat and solidifying when cooled. Therefore, granular form hot melts are especially suited to bonding such impervious surfaces as polyethylene, foil and other synthetic films.—**National Starch Products Inc., New York, N. Y.** 90A

Refractory

Protects floors of marine and stationary boilers.

A new basic refractory material has been formulated especially for protecting the floor surfaces of marine and stationary boilers.

Refractory linings of these boilers are subject to fluxing caused by the action of noncombustible impurities present in many fuels. A slag is formed which remains molten at operating temperatures but forms into a solid, rock-like mass, bonded to the boiler floor when it cools. Often as much as 10 in. of slag accumulates during a year of operation requiring the use of pneumatic hammers for removal in order to replace or repair worn linings.

Called Oceanite, the new refractory is a granular product capable of absorbing the slag while retaining its refractory properties. When cooling occurs, the Oceanite, laden with slag, remains crumbly and can be removed with little effort when repairs are necessary.

It is made from high-purity periclase, a crystalline dense magnesia.—**Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland, Calif.** 90B

Nylon Granules

For extrusion of large shapes.

A new nylon compound for large extrusions has been developed to meet the need of extruders for an ultra-high melt viscosity material.

Called Plaskon Nylon 8205, it can be extruded at stock temperatures ranging from 450 to 550 F. The form in which it is supplied—minute cylindrical granules only 1/10 by 1/10 in.—is said to facilitate even control of stock temperature. It also produced a homogeneous melt aiding in the production of uniform end products with close dimensional tolerances and optimum appearance.

Because of the compound's exceptional stability, it can, with proper handling, be reextruded several times, since maintenance of high melt viscosity through successive regrinds is one of its unique characteristics.—**Barrett Div., Allied Chemical Corp., New York, N. Y.** 90C

Polyethylene Coating

For paper, cellophane and foil.

A new polyethylene extrusion coating resin permits lower coating weights and increased economy in treating paper, cellophane and foil. Responsible is its melt index of five and excellent draw-down.

Designated 610M, it has been applied with comparitively good adhesion in thicknesses of 0.2 mils, and has been run experimentally all the way down to 0.1 mil.

Use of the resin gives decreased neck-in and consequent decrease in beaded edge. To the laminator this means less trimming as well as less waste.—**Dow Chemical Co., Midland, Mich.** 90D

Calcium Carbonate

Low cost grade of dense type precipitated compound.

Development and availability of Carbium, a new, low cost grade of dense-type precipitated calcium carbonate has been announced.

As an extender for flat wall paints of both alkyd and resin emulsion types, it is said to provide uniform flattening at high pigment volume. It gives reduced streaking, flashing or ghosting of medium shades and deep tones.

As a filler in rubber compounds, Carbium provides fast mixing cycles, good dispersion and color stability. In addition, high loading tolerance enables the material to be used in compounds where low modulus and low cost are musts.—**Diamond Alkali Co., Cleveland.** 90E

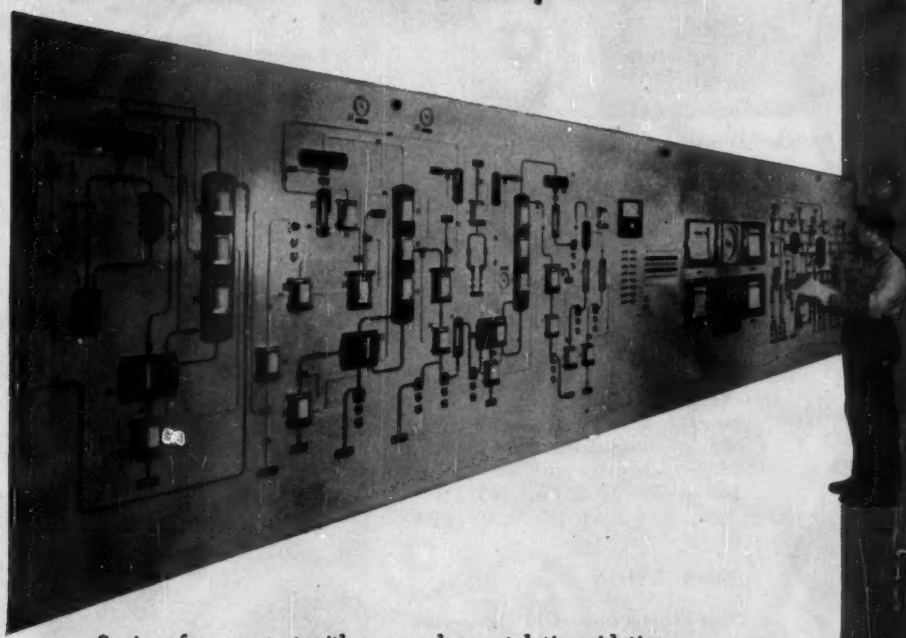
BRIEFS

Wool-like qualities for cotton or new gelatins that could be useful as blood plasma or for photographic film may be the result of a new method for introducing sulfur into proteins. Sulfur was introduced through the use of an amino acid derivative called n-acetyl-homocysteine thiolactone.—**Marine Biological Lab., Woods Hole, Mass.** 90F

Films and molded products made of any type of polyethylene can now be decorated and protected with a new synthetic coating which is applied by dip or spray techniques. Tradenamed Nylene, it is reported to impart a hard, glossy finish and to increase clarity.—**U. S. Industrial Chemicals Co., New York, N. Y.** 90G

Protected form of vitamin B_{12} cuts potency losses more than 50 percent. Key is a pharmaceutical grade ion exchange resin which absorbs the vitamin so that it remains unaffected by other compounds contained in tablet and capsule preparations. — **Chas. Pfizer & Co., 800 Second Ave., New York, N. Y.** 90H

Direct Continuous Process
makes
NATIONAL® MALEIC ANHYDRIDE TABLETS
Economical and Easy-to-Use!



Savings for you start with our modern catalytic-oxidation process in the world's largest Maleic Anhydride-Fumaric Acid plant. All basic materials come from within the Allied Chemical group. Our exclusive catalytic-oxidation process is direct, continuous, automatically-controlled, uniform.

We tablet National Maleic Anhydride under controlled-pressure into a dense, smooth, "cornerless contour" form that shows minimum degradation from our plant to your kettle.

Screen analysis of leading brands after a 1,000-mile truck haul shows drums of National Maleic Anhydride Tablets have 75-90% fewer fines.

And for extra savings, you get mixed car or truckload rates on combination orders for any of the resin-chemicals listed from plant or nearby branch warehouse stocks.

Start saving now by getting our quotation on your needs.

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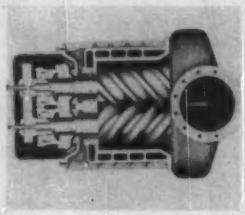
Akron Atlanta Boston Charlotte Chattanooga Chicago Greensboro Los Angeles
New Orleans Philadelphia Portland, Ore. Providence San Francisco Toronto

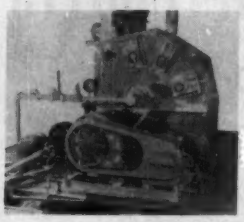
Allied Chemical

Current Developments Lineup



Rotary Compressors

Positive-displacement series features high efficiency, stability. **92A**

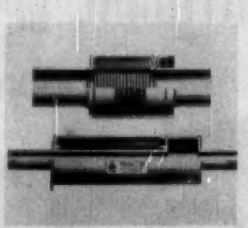


Powder Densifier

Vacuum filter plus rollers up product density by 100-200%. **92C**

Multicapacity Bag

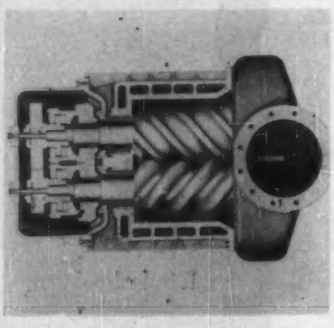
Length and width remain constant; thickness varies with product. **94A**



Expansion Joints

New line available for conditions to 1,000 F., and 700 psig. **94B**

Page number is also Reader Service Code Number



Rotary Compressors

High-efficiency line features smooth operation.

A new line of positive-displacement rotary compressors rivals the efficiency and stability of reciprocating machines, while matching the low maintenance and compactness of centrifugals, according to the manufacturer. Designed for continuous service handling air, gas or vapor, the axial-flow line has a capacity range of 800-13,000 cfm.

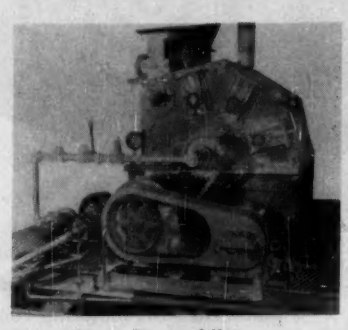
The two helical-lobe impellers of the machine do not come in contact with each other or with the casing—lubrication is unnecessary. Standard casings are cored with water passages for cooling. Five standard sizes, in single- and multi-stage units, are available for pressure, vacuum or booster service.—**Fairbanks, Morse & Co., 565 Fifth Ave., New York 17, N. Y.** **92A**

Fuel Filter

Flameouts and missile aborts lead to new unit.

Petroleum refineries and other process industries may benefit, in some of their operations, from a new equipment development of the jet and missile age. One problem that plagues the use of hydrophilic jet and missile fuels is freeze-out of contaminating moisture at high altitudes.

The new Perma-Dry, claimed to be better than previous water filters for these fuels, has shown promising results. Perma-Dry uses a successive series of filtering agents—first a synthetic fabric, then a bonded bronze filter and finally, a glass fiber pad—to remove all haze or emulsified moisture and debris greater than about 1.6 microns in size. Units will soon be available in capacities of 50-1,500 gpm.—**Permanent Filter Corp., 1800 West Washington Blvd., Los Angeles 7, Calif.** **92B**

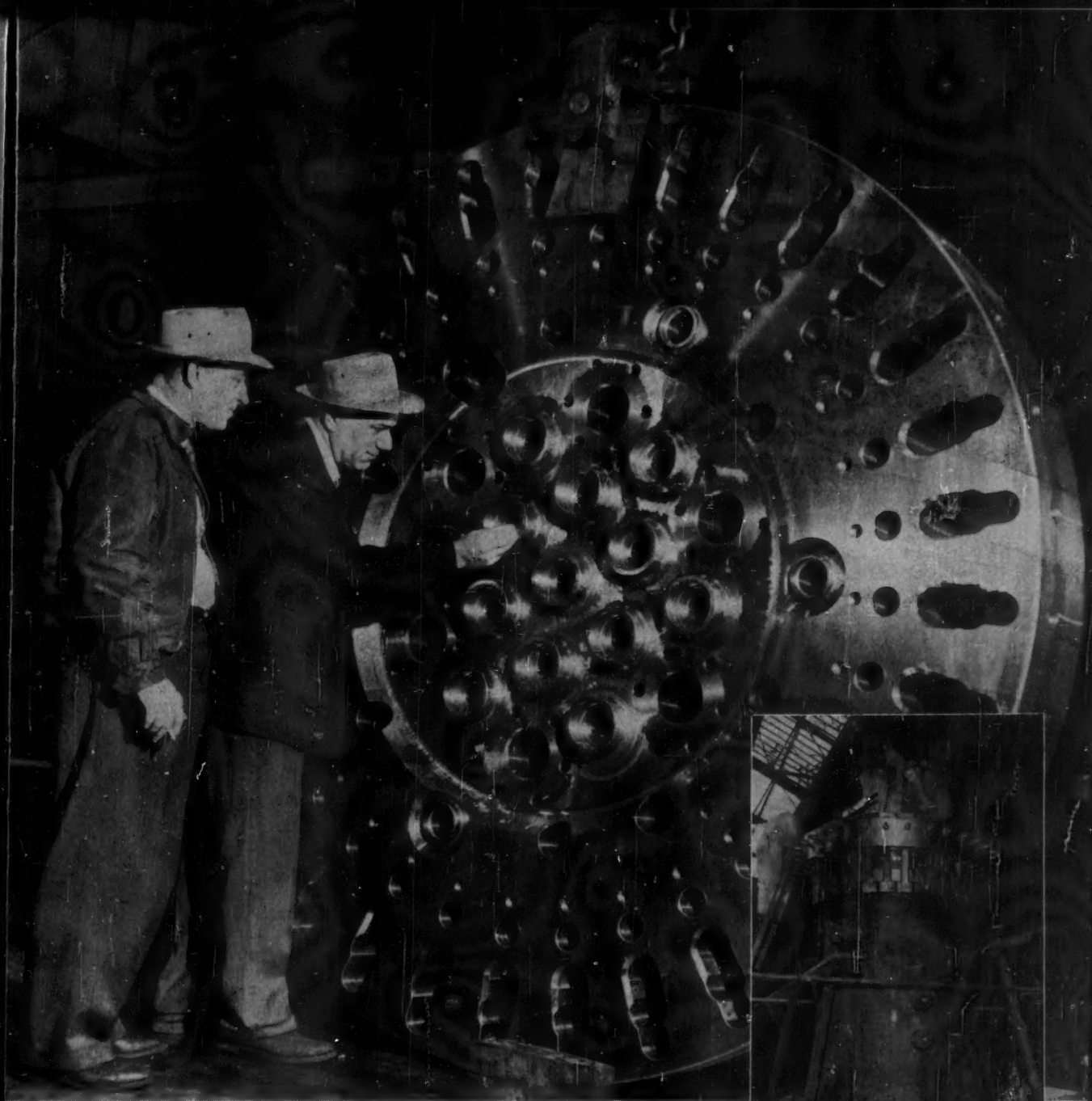


Powder Densifier

Reduces packaging and transportation costs.

The new Huber Densifier removes entrained or occluded air from fine, loose, powdered materials to produce a more salable, higher-density product. Consisting essentially of a rotating filter drum and a series of adjustable rollers, the machine densifies by simultaneously applying vacuum filtration and mechanical compression to the continuous feed stream.

Already proven by a number of commercial applications, the unit ups product density by 100-200%. Manufacture and use will be licensed by Huber to any interested firm.—**J. M. Huber Corp., P. O. Box 831, Borger, Tex.** **92C**



FOR NUCLEAR NEEDS of Knolls Atomic Power Laboratory, M. W. Kellogg was given the exacting assignment of designing and producing a 32½-ton "Proof Test Reactor Pressure Vessel". This was an unusually complex task, because of the quick-opening closure specifications, requiring a head with novel design and extremely close tolerance machining.

FOR NUCLEAR NEEDS of others, Kellogg is supplying the primary coolant stainless piping for two nuclear plants. In addition, Kellogg is equipped to engineer and manufacture heat exchanger equipment for nuclear energy power plants. If these specialized skills suggest a solution to *your* nuclear problems, call Kellogg's Fabricated Products Sales Division.

This pressure vessel had to be designed with a closure that would open in 30 minutes, and withstand 1500 psi, 550F. Made of Type 304 stainless, the top head has 34 connections, of which 19 required exceptionally close tolerances for control rods.

THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17.

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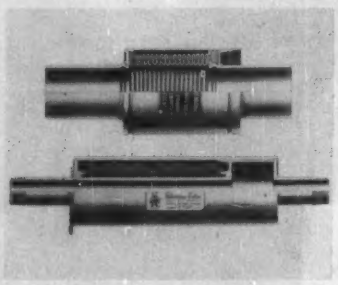
M KELLOGG W

Multicapacity Bag

Permits standardization of pallet patterns.

A new type of multiwall bag features a pasted valve reducing insert that allows variation of bag capacity—without altering the two dimensions that govern pallet patterns. Length and width of the bag remain constant; filled thickness varies from 3½ to 6½ in., depending on the density of the packaged product.

Also, design of the self-sealing valve insert insures against costly spillage. The three-ply bag of Kraft paper, which lends itself more readily to high-stacking, is 22½ in. wide and 25 in. long.—**Multiwall Bag Div., Owens-Illinois Glass Co., Toledo, Ohio.** 94A



Expansion Joints

Three new packless models join equipment line.

A new set of pipeline expansion joints for corrosion service meets either high- or low-pressure industrial requirements. The packless joints, which are available for a variety of pipe sizes, feature increased effective stroke and low price.

Model 1290 is suitable for steam and hot water lines under low pressure; Model 1291, equipped with stainless steel bellows, has a working pressure of 150 psig. Of particular applicability to the process industries, Model 12139R operates at temperatures to 1,000 F. and pressures to 700 psig. Its all-welded construction is entirely stainless steel.—**Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville 1, Tenn.** 94B

Start-Up Strainers

For steam, oil and water process lines.

A line of new, large-size strainers prevents dirt, mill-scale and other debris from reaching pumps, exchangers, boilers and other equipment during start-ups. Easy-removal design enables re-use of the strainer on other lines if desired. Or, the entire assembly may be left in place permanently—pressure drop across the screen is not excessive.

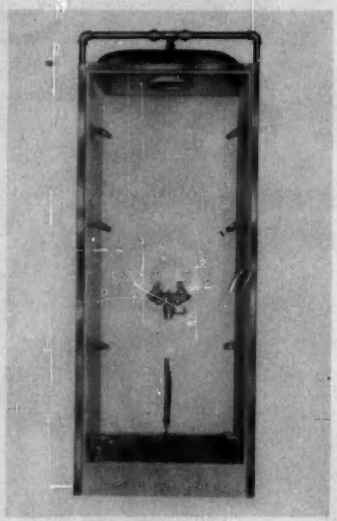
Operating personnel can clean the strainer in about 10 min. by inserting an air, steam or water lance into a special port; trapped debris falls into a cleanout drain. Available in 6 to 16-in. steel spools with 150 or 300-lb. flanges.—**Leslie Co., 63 Delafield Ave., Lyndhurst, N. J.** 94C

Industrial Ovens

Boast high efficiency and low floor space.

Two new ovens, designed for drying, baking or curing, feature a built-in recirculating air system to assure increased efficiency and uniform temperatures throughout. Direct-fired gas burners provide temperatures from 200-600 F. Electrical, oil or steam heating equipment is also available.

Centralization of all operating controls, instrumentation and safety equipment on one control panel results in simple, convenient operation. Type 110 has a width of about 11 ft., height of 10⅞ ft. and depth of 9⅜ ft.; Type 40 is about 5⅝ x 9½ x 7 ft.—**Kirk & Blum Mfg. Co., 3100 Forrer St., Cincinnati 9, Ohio.** 94D



Safety Shower

Torrential downpour cuts personnel injuries.

All emergency safety facilities operate instantaneously when an accident victim jumps into this new decontamination stall. Activated by the floor treadle, an overhead shower unit drenches the victim to wash away injurious materials. Simultaneously, eight body-spray nozzles assure complete washing coverage, and a controlled-pressure fountain allows eye and face cleansing.

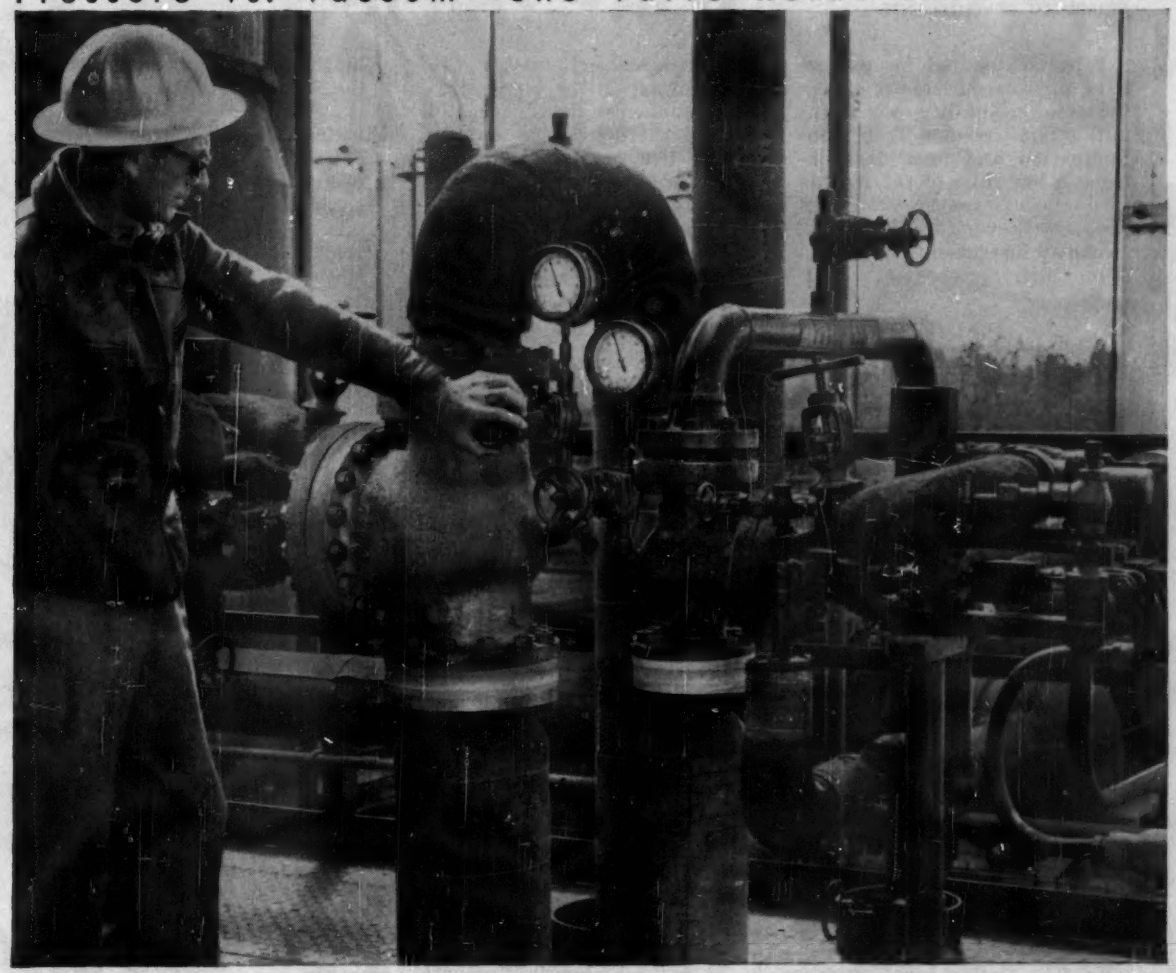
The one-piece, glass-fiber stall comes ready for attachment to water supply and drain system. A freeze-proof unit is also available.—**Haws Drinking Faucet Co., 4th & Page St., Berkeley 10, Calif.** 94E

Dry-Grinding Mill

Uses unique technique to reduce particle size.

Known as the Spinmill, a new milling instrument uses centrifugal force to fracture crystalline particles as large as several hundred microns down to a 1- or 2-micron particle size.

Pressure vs. vacuum—one valve holds both in line



Gauge test of Crane flexible wedge disc gate valve shows no leakage around disc.

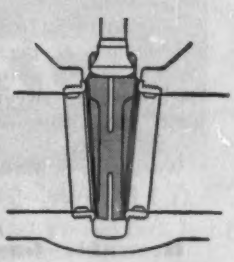
How one CRANE valve controls two-fluid process

To prevent intermixing of steam and very light hydrocarbon in a butadiene production process, the Texas Butadiene & Chemical Corp., Channelview, Tex., uses only one valve. This is unusual; the old method of double blocking required two valves.

The single valve being used is a Crane flexible wedge disc gate. In the operating cycle, this 6-inch, 400-pound air-cylinder operated valve opens or closes every seven to nine minutes. In closed position, one side of the disc holds steam at 20 psi. The other side holds light hydrocarbon at 24 inches mercury vacuum.

This dual service, combined with constant cycling, is beyond an ordinary wedge gate or plug type valve. But not beyond the Crane flexible wedge disc! It has prevented leakage and product contamination month after month on this tough service.

For full information about the efficiency and obvious economies of using Crane flexible wedge disc gate valves, see your Crane Representative or write to address below.



Positive wedging principle of Crane flexible wedge disc gate valve.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

Especially suited for pulverizing pharmaceuticals to obtain increased solubility, the Spinmill offers freedom from contamination and heat degradation. A low ratio of carrier gas to feed mass greatly simplifies product recovery.—**Spinco Div., Beckman Instruments, Inc., Palo Alto, Calif.** 94F

Snap Valve

Features fingertip shutoff of gas flow.

A new, low-cost snap valve gives split-second safety control on gas lines for emergency shutoffs. The slotted brass plunger slides in an all-bronze casing on fingertip pressure — synthetic O-rings form the seal.

Available for ⅛-, ¼-, ⅜- and 1-in. pipe sizes, the valve is claimed to have leakproof performance at pressures to 200 psi. Colored plunger ends distinguish between open and closed positions.—**Seaman Snap Valve Co., 175 Mechanic St., Worcester 8, Mass.** 96A

Reusable Gaskets

Improve service of hermetically sealed equipment.

Made of thin-wall metal tubing, internally pressurized at 1,000 psi., the Gaseal permits easy access to, and re-sealing of, hermetically sealed equipment. The same gasket is reusable many times.

According to the manufacturer, Gaseal eliminates the need for lapped or highly polished surfaces. Resiliency and sealing characteristics at high or low temperatures and pressures are unaffected by continued re-sealing. Available in circular, elliptical or irregular shapes in a variety of sizes.—**General Hermetic Sealing Corp., 99 East Hawthorne Ave., Valley Stream, N. Y.** 96B

BRIEFS

Stoppering device, a new addition to a standard line of freeze dryers, automatically sets the stoppers into bottles and vials while they are still under vacuum.—**F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.** 96C

Extruder, capable of attaining controlled pressures to 10,000 psi., is available in 1½ to 6-in. sizes with a 21:1 L/D ratio. Claimed to increase production by 100%.—**J. M. C., 683 Frelinghuysen Ave., Newark, N. J.** 96D

Manhole assembly for working pressures to 25 psi. is designed for resistance to corrosion and contamination. Comes in stainless and glassed steel. Ring opening is 13 x 18 in. — **Bishopric Products Co., 4413 Este Ave., Cincinnati 32, Ohio.** 96E

Solar furnace assembly, including fully automatic electronic solar tracking system, is now available for industrial materials testing at up to 7,000 F.—**Thermal Dynamic Products, Inc., 38 West 53rd St., New York 19, N. Y.** 96F

Nickel-coated valve line has the same corrosion resistance as higher-cost solid nickel or stainless steel, yet improved mechanical and physical properties. — **Rockwell Mfg. Co., 400 North Lexington Ave., Pittsburgh 8, Pa.** 96G

Glass-fiber insulation, known as Therma-K exterior duct and equipment insulation, provides thermal conductivities of only 0.25 Btu./(hr., sq. ft., deg. F/in.) Low density and long life. — **Ehret Magnesia Co., Valley Forge, Pa.** 96H

Plastic dump chute of polyvinyl chloride protects the manhole of glassed-steel reactors. Designed to fit inside 12 x 16-in. manholes, the chute is easily removed.—**The Pfaudler Co., Rochester 3, N. Y.** 96I

Flow meter, which reads as low as 1 cc./hr., measures low flows of virtually any type of vapor or gas. A differential pressure gage provides the readout. — **George K. Porter, Inc., Hatfield, Pa.** 96J

Tubing swabs with interchangeable rubbers are designed for extreme flexibility of operation—they automatically adjust themselves to different loads.—**Byron Jackson Tools, Inc., Los Angeles, Calif.** 96K

Equipment Cost Indexes

	Dec. 1957	March 1958
Industry		
Avg. of all	229.2	231.2
Process Industries		
Cement mfg	220.7	222.9
Chemical	230.4	232.4
Clay products	214.4	216.6
Glass mfg	217.6	219.4
Paint mfg	221.6	223.8
Paper mfg	222.0	223.9
Petroleum ind	226.3	228.6
Rubber ind	229.1	231.4
Process ind. avg	227.0	228.8
Related industries		
Elec. power equip	232.9	234.2
Mining, milling	231.8	233.8
Refrigerating	258.9	261.5
Steam power	216.9	219.5

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 142–4 for annual averages since 1913.

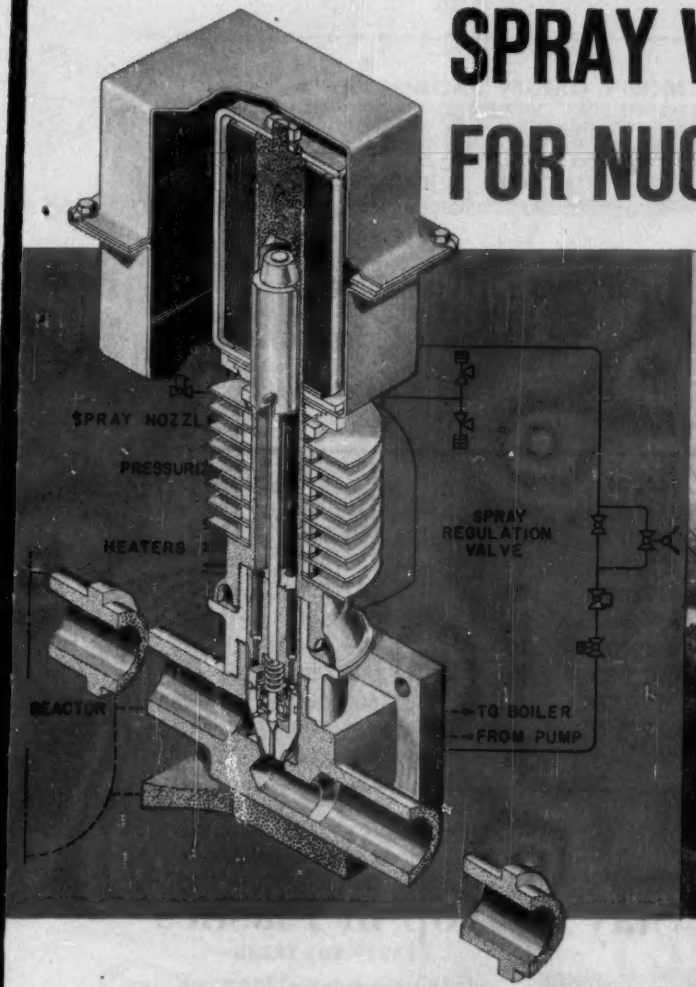
For More Information . . .

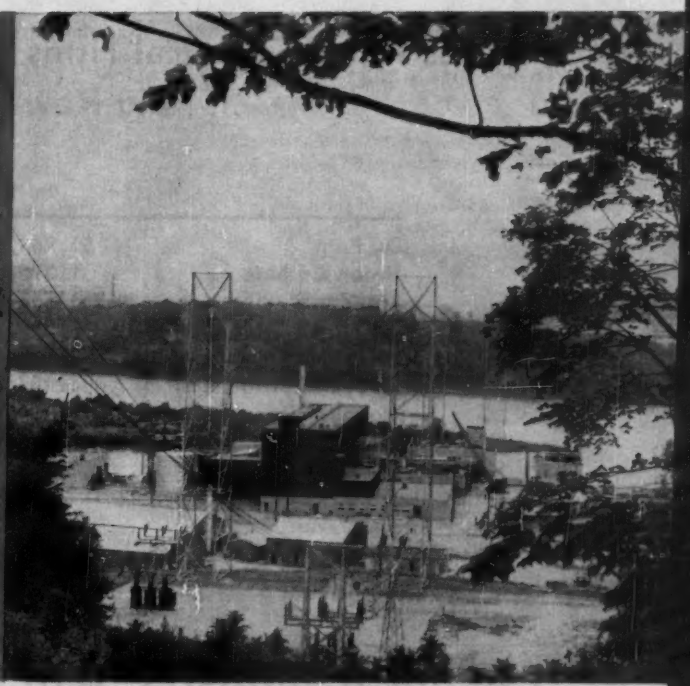
about any item in this department, circle its code number on the

Reader Service

postcard (p. 191)

SPRAY VALVE FOR NUCLEAR REACTORS...





ASCO SOLENOID VALVE CONTROLS PRESSURE SURGES

ASCO – the only solenoid valve manufacturer in the industry with complete nuclear energy test facilities including a *hot test* loop – now offers a family of solenoid valves designed specifically for atomic energy applications.

The Spray-Valve shown in the cutaway above was developed especially to control pressure surges in the water cooled pressurized reactor. All stainless steel with stellite seats and discs, this unit has demonstrated reliability and maintenance-free operation under tests which duplicated the most strenuous operating conditions.

This packless type (hermetically sealed) solenoid valve is capable of large volume flow at low pressure differentials, handles pressures of 2500 p.s.i., at 675°F. Normally closed (closed when de-energized), it is supplied in 1", 1½" and 2" sizes.

ASCO Spray Valves are in use at Shippingport Atomic Power Station, and aboard nuclear submarines powered with water cooled reactors. Reliable and maintenance-free, ASCO 2, 3 and 4-way valves are specified for primary and secondary systems of nuclear reactors, as well as for instrumentation control.

For further information, request "ASCO Valves for Nuclear Reactors" and Catalog No. 202.

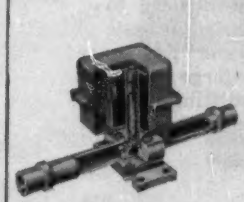
ASCO®

Automatic Switch Co.

50-D Hanover Road, Florham Park, New Jersey
FRontier 7-4600

Typical ASCO Solenoid Valves for submarines, military and commercial surface ships, and industrial power plants:

Primary System

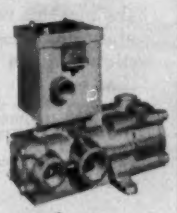


Isolating (Stop) Valve

Pressure Operated 4-way Valve

Secondary System

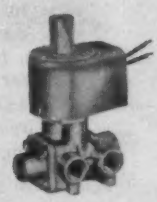
Manual Reset 2-way Valves



4-way Valves

Instrumentation Control

Manual Reset Valves



4-way Valves

Plastics Race: Chemical Firms Ride the Driver's Seat . . . . . Big Rewards and Heavy Commitments

	1957 Sales (Incl. Plastics)	Plastics (% of Sales)	Debt	Debt as % of Working Capital
Du Pont	$1,964,624,000	22*	0	0
Union Carbide	1,395,033,000	25	$400,386,000	95
Monsanto	708,000,000	30	224,700,000	135
American Cyanamid	532,479,000	13	92,750,000	55
Dow Chemical	627,819,000	33	132,622,000	158
Hooker Electrochemical	107,868,000	25	35,002,000	111
Hercules Powder	245,265,000	10	0	0
Rohm & Haas	174,053,000	23	4,000,000	17
Spencer Chemical	48,263,000	28	22,500,000	93
Allied Chemical	683,079,000	6	192,459,000	119
Celanese	192,297,000	18	84,500,000	122

* Chem. Eng. estimate

Chemical Industry Will Stay on Top in Plastics

To ride highest on rushing plastics currents, you need two things: money and know-how that reaches from raw material to consumer. Chemical firms have both.

Richard P. Windisch, W. E. Burnet & Co., New York, N. Y.*

Production of basic plastic materials—simple monomers and polymers—is now centered, to a large extent, in our chemical companies, which have developed advanced compounding know-how.

As the plastics industry grows by leaps and bounds, however, there's a tendency for large oil companies to integrate their petrochemical products toward plastic intermediates. And a tendency for rubber companies to enter the field with their experience in the type of marketing and distribution which many plastic products require.

Nevertheless, we feel that, because of the numerous types of plastics developing and the fabrication problems involved, chemical companies have a strong advantage.*

They will win the commercial race because sources of basic plastic raw materials—coal, oil, sand, gas salt and soon, perhaps, phosphate rock and borax—are varied and shifting as the industry matures. At the same time, required compounding ingredients also change. And the bulk of the $150-million plastics-additive business is already in the hands of chemical firms.

Chemical companies will win the plastics race because the constant changes in processing techniques mean a great amount of sale and engineering service must accompany the marketing of polymers. Manufacturers of materials must show thousands of fabricators how to get best results from their products so that the fabricators can, in turn, satisfy their customers. This means an expensive organization with many technologists, engineers and researchers.

▶ **Plastics: Whose Baby?**—Neither petroleum nor rubber companies are today as well equipped as chemical firms to supply sales and engineering services to the multitude of plastics fabricators springing up.

Many rubber companies have become fabricators because plastic products can be conveniently handled by existing retail marketing and distribution organizations. Yet it is hard to see how they can thrive in basic monomer and polymer production, what with the large capital requirements and shifting chemistry expected in such a youthful product.

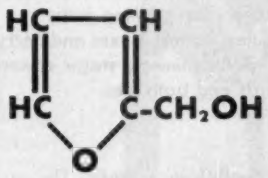
* There are now 17 basic types of plastics commercially produced. The art of blending and copolymerizing these to give desired properties is rapidly complicating manufacture.

* Meet your author on p. 176.

A TECHNICAL MEMO FROM THE QUAKER OATS COMPANY

ON QO® FURFURYL ALCOHOL (FA)

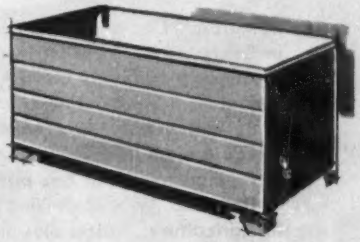
QO FA® is a simple heterocyclic compound consisting of a furan nucleus and an hydroxymethyl group. Graphically, its structural formula makes an interesting subject for confirmed doodlers—many a QO memo pad looks like this . . .



Broadly speaking, furfuryl alcohol has two main industrial applications: (1) it readily resinifies when catalyzed by acidic reagents; (2) it dissolves as well as reacts with many resins. Add to these qualities its value as an important chemical intermediate, and you get an idea of its versatility.

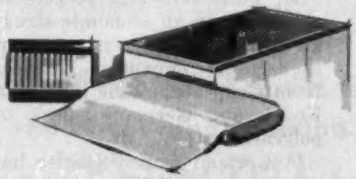
GREAT FOR GLUERS

Glue manufacturers use QO furfuryl alcohol to make gap-filling adhesives based on the urea-formaldehyde resins. Exceptional strength is one happy result. And, too, they get glues that are flexible and resist crazing and deterioration upon aging. Other plus values include reduced shrinkage and the assurance of an enduring bond under varying conditions of pressure, temperature and glue line thickness.



Adhesive manufacturers can vary the properties of their glues by varying the amounts of FA used. Thus they can offer industry a broad range of glues from which a customer can choose one or more virtually "custom-made" for his purpose.

Typical applications include lumber core gluing, assembly gluing of furniture and other wood to wood gluing operations where joints rarely are uniformly matched.



A LOOK AT SOME OTHER USES

Many industries are turning the investigative spotlight on QO furfuryl alcohol and coming up with a rather amazing variety of applications. Here are but a few . . .

RESINS

- **Manufacture of corrosion-resistant products**
- **Binder in resinous mortars, cast-molded asbestos-filled items**
- **Manufacture of laboratory table tops which are impervious to common solvents, alkalies and most acids**
- **Impregnating agent for porous substances**
- **Manufacture of asphalt battery cases**

SOLVENT

- **Dye solvent and dispersant for difficultly soluble textile dyes**
- **Excellent solvent for phenolic and epoxy resins**
- **Wettant and reactive solvent for resin-bonded abrasives**

WE'D LIKE TO HELP

Write today for Bulletin 205. It contains general informaiton on QO furfuryl alcohol, its physical data, chemistry and current uses. And, of course, our technical staff is anxious to assist you in any investigative problem involving FA.

The Quaker Oats Company

CHEMICALS DIVISION

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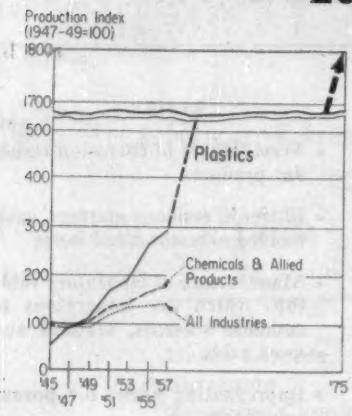
In Japan:
F. Kanematsu & Company, Ltd., Tokyo

26 Billion Lb. of Plastics by 1975



Here, there, everywhere: Uses with a future—

in Autos: 11 lb. of plastics/car in 1956; 32 lb./car in 1961
in Boats: 55,000 small craft with reinforced-plastic hulls
in Aircraft: For every Convair, 1,000 lb. of structural polymers
in Trains: Plastic Pullman lavatories from a single mold
in Building: $142 million worth of plastics today for 100 different uses
in Equipment: 50,000-gal. tanks; 77-ft.-high, 4½-ft.-diam. stacks
in Piping: 150 mi. of 2-in. pipe in Texas; 6,200 ft. of 6-in. pipe in Ohio
in Defense: ⅝-in. glass-filled armor plate; 105-mm. shell casings
in Agriculture: Plastics silos and covers for growing crops
in Packaging: Carboys and ampoules; battery boxes and berry baskets
and: Shoe heels, missile housings, clothes linings, stage scenery, movie cameras, telegraph poles, signboards and bath tubs.

It is our opinion that the lush times and easy money have attracted many fortune hunters to the plastics industry. When rigid economies are required, many will "return to their knitting", leaving plastics to chemical companies where they belong.

Actually, the future of plastics is so tremendous, and the stakes are getting so large, that the going is sure to be rough for anyone not well supplied with cash.

▶**Money Talks**—In rating the plastics potential of a company, we feel nothing can take the place of financial strength. Patents and processes can be leased (particularly from abroad) by those with the capacity to build plants. Selling and servicing talent can also be bought if you have the funds.

The high long-term debts in relation to working capital incurred by such companies as Dow, Celanese Corp. and Monsanto show the financial strain companies are under to keep up with the technological race in plastics.

Some results of the struggle among plastics producers for outlets are the numerous recent tieups with converters: Union Carbide with Visking, Dow with Dobeckmum, American Cyanamid with Formica, Monsanto with Plax, Hooker with Durez.

▶**Bang-Bang**—And plastic product developments have been coming with astounding rapidity.

Hercules last fall announced this country's first polypropylene, Pro-Fax. Du Pont announced Delrin, a new high polymer from formaldehyde. Union Carbide will build a plant in West Virginia to make Polyox, a soluble high polymer of ethylene oxide.

In the infant polyurethane field, polyesters and polyethers are locked in an economic struggle which may be very important to certain companies. Releases from General Electric, Eastman Kodak and Germany speak of polycarbonates.

A German named Ziegler has developed a catalyst which has turned the polyethylene industry upside down. The great Italian chemical company, Montecatini, has shown the way to many new polymers through use of another unique catalyst—titanium trichloride.

But plastics development isn't merely mergers or a stream of new products added to the list. It involves high competition among types, and loss of markets due to newer developments.

A new technological development actually can wipe out a company's leadership in a product or process almost overnight. Funds must be available to start over again on a new course, if necessary.

In 1957 Hercules announced it would no longer manufacture cellulose acetate. Union Carbide said it would drop polyester resins from its line. Hercules this year abandoned plans for making a polyacrylic resin since it appears present manufacturers can easily supply current demand.

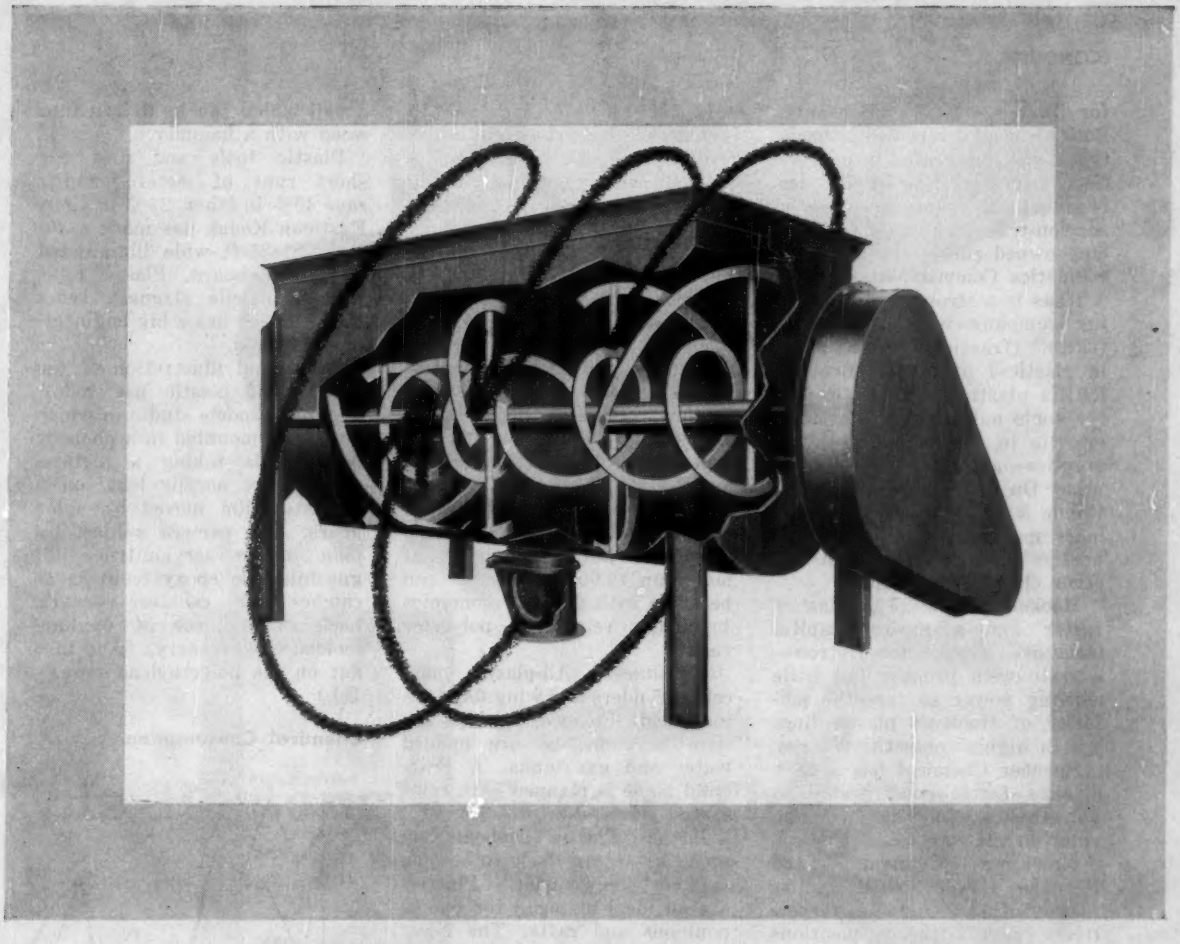
A severe jolt was given the whole polymer industry when Du Pont was granted a composition patent covering linear polyethylene. To the near-dozen companies sinking large sums into this product and paying royalties to Ziegler, Philips and Standard Oil of Indiana, the news was alarming.

▶**Company Lineup**—Lets take a closer look at these and other chemical companies heavily committed to plastics and see where they stand.

Du Pont unquestionably is in the forefront when it comes to investing in high polymers. Its gross sales in this field, when fibers, film and resinous coatings are included, are probably larger than those of any other company—and probably make up as much as 50% of total company sales.

Union Carbide probably leads in types and volume of straight plastics, since its fibers and resinous-coatings business is small. Carbide's plastics volume is about 20% of total sales, and close to 14% of our entire national plastics output.

Dow Chemical and Monsanto Chemical have the highest concentration of sales in the plastics field. 33% of total company sales



counterflow is key . . .

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You'll cut processing time, increase mixing efficiency with Readco Spiral Ribbon Mixers

Counterflow action of ribbon agitators accounts for thorough, high-speed blending, assures equal mixing throughout the entire volume.

Designed for batch or continuous mixing or blending of pulverized, granular, dry or wet materials, these mixers are supplied for operation under pressure or vacuum, with or without temperature controlling jackets.

Heavy-duty construction of carbon or stainless steel permits efficient service under long runs and rugged operating conditions. Working capacities range from 1 to 650 cubic feet.

For more information see Chemical Engineering Catalog pages 1483 to 1490 . . . or write direct.

READCO

Whatever the mixing job: a READCO mixer!

READ STANDARD
York, Pennsylvania
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for Dow, 30% for Monsanto. Both are well diversified in basic types, well integrated in production. Dow's position in silicones is unique; Monsanto is strong in acrylonitrile and nylon through 50%-owned subsidiaries.

▶ **Plastics Commitments**—Rohm & Haas is a strong and promising company with a "plastics factor" (fraction of total sales in plastics) of 22½%. Most of R&H's plastic interests, except for some outstanding plasticizers, lie in one basic type, the acrylics—a market it shares with Du Pont and Celanese. Rohm & Haas stock has done more marketwise for its stockholders since the war than any other chemical company.

Hooker has a 25% plastics factor and a modest capital structure. Except for Hetron—a resin with promise but little earning power so far—the majority of Hooker's plastic lines are in highly competitive types.

Spencer Chemical has a 28% plastics factor concentrated in polyethylene, but has a nylon plant on the way.

American Cyanamid and Hercules Powder, with plastics factors of 13% and 6%, respectively, have advanced positions in their particular specialties of melamine and polypropylene. Cyanamid also has a strong trade position in decorative laminates (Formica) and in melamine which leads the $70-million plastics-tableware market. Hercules, with its new investment in polypropylene, will probably have a 10% plastics factor by the end of the year, and is among the few big chemical companies with no outstanding debt.*

It's easy to see why there's so much interest.

The plastics industry has such great promise in the replacement of other materials that it needs neither inflation, an expanding economy nor sustained government spending to carry it forward.

In fact, plastics bid well to become the largest single outlet for the chemical industry—particularly when they finally break through as large-scale engineering materials of construction.

They've already got a foot in the door:

Automobiles: Prospective spots for greater plastics use will be foamed upholstering, floor panels, molded seats, transmission gears, epoxy parabolic reflectors and acrylic lenses in lamps. A 1958 Ford model has a plastic hard top, a Studebaker model has a plastic hood overlay, and an International Harvester truck a plastic grille. Undoubtedly future automobile models of less than 10,000 in number can be made with distinct economies by using reinforced polyester resins.

Airplanes: All-plastic nascelles, rudders and wing flaps are imminent. Foamed-in wings are sure to come, as are molded water and gas tanks. A Fairchild plane is planned with reinforced plastic wings.

Boats: Plastic lifeboats on ocean liners are likely to become standard equipment. Plastics are an ideal material for buoys, pontoons and rafts. The Navy has built 28 whaleboats of plastic, is a large user of plastic pipe. Nylon propellers and fittings can be cheaply formed and save weight, as do nylon, vinyl and polyethylene cable.

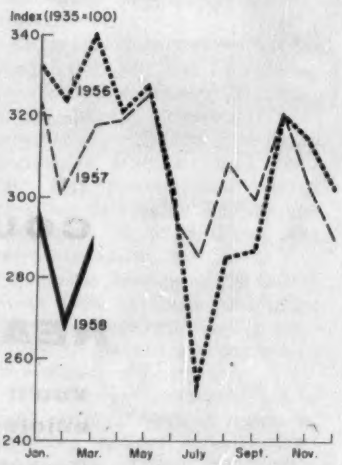
Homes: Monsanto's "Plastic House" incorporates 80 different uses. Goodrich lists 100 distinct home uses for plastics, such as floors, walls, ceilings, skylights, ventilating and air-conditioning ducts, roof shingles, flashing, outdoor sheathing, plumbing fixtures, pipe insulation. Other novel uses: bath tubs, swimming pools, louvers, concrete molds. Total value of plastics and resins used in building was $142 million in 1956. These plastics were, in turn, worked into building materials valued at $500 million.

▶ **From A to Z**—A new England genius has concocted a mixture of steel powder (80%) and epoxy resin. This plastic steel can be used to patch anything from kitchen stoves to battleships. General Electric's new polycarbonate, Lexan, will make a nail which can be driven into wood with a hammer.

Plastic tools and dies for short runs of metal forming save 40% in labor, 25% in time. Eastman Kodak has made a 40-ft.-high, 25-ft.-wide illuminated plastic signboard. Plastic rope, with a tensile strength twice that of steel, has a big engineering potential.

As a final illustration of the breadth of plastic use today, imagine a movie studio in which a camera, mounted in a phenolic housing, is taking a picture, through an acrylic lens, on a polyester film moved by nylon gears. The camera subject: a man in an acrylonitrile suit gnashing his epoxy teeth as he catches his cellulose acetate heels on a piece of vacuum-molded vinyl scenery. (And falls flat on his polyethylene nose.—Ed.)

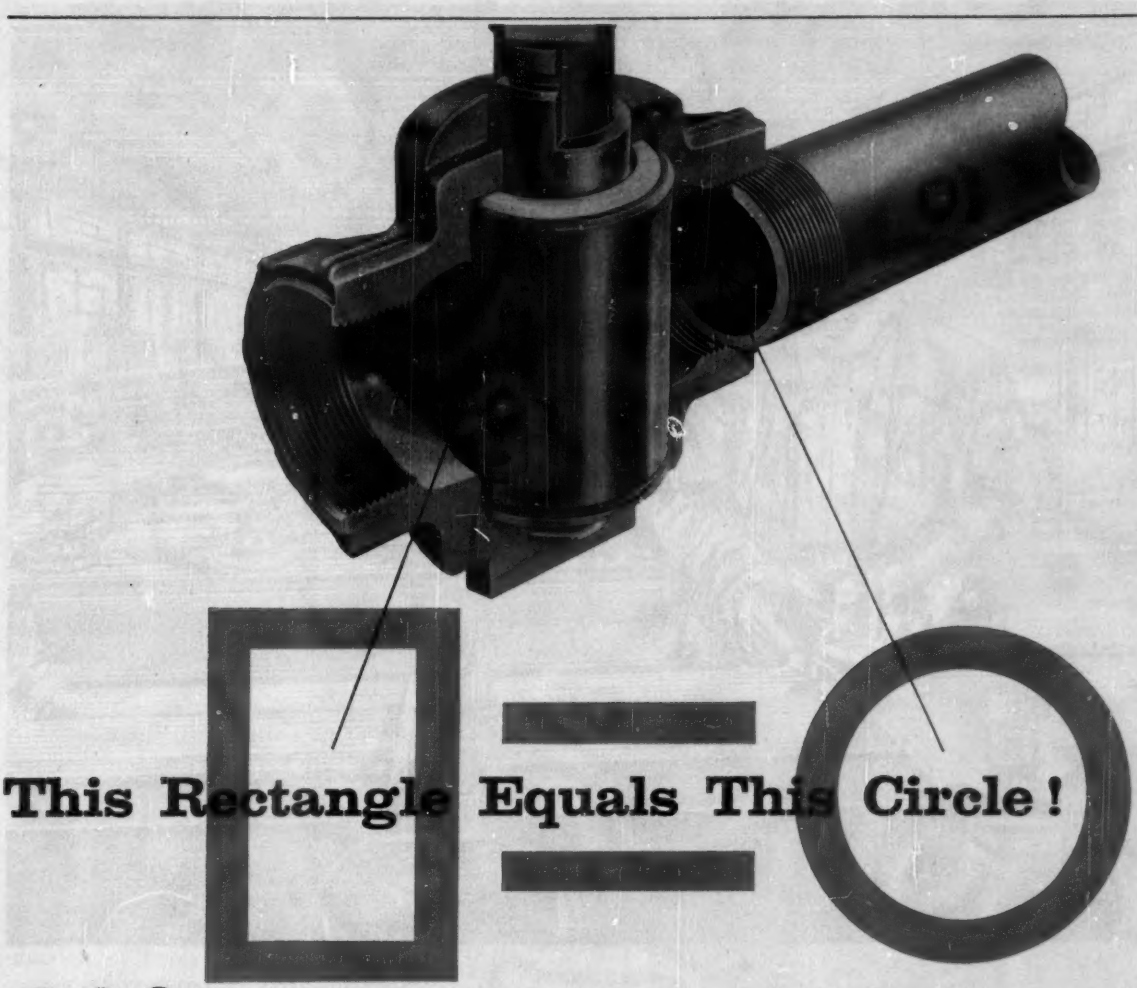
Chemical Consumption



Consumption by Industries

	Feb. (Final)	March (Est.)
Coal products	7.2	7.9
Explosives	8.4	8.8
Fertilizer	70.2	76.8
Glass	24.0	25.0
Iron & steel	10.6	11.5
Leather	3.9	3.9
Paint & varnish	25.0	28.2
Petroleum refining	27.3	29.5
Plastics	21.8	23.2
Pulp & paper	33.7	36.6
Rayon	21.8	23.4
Rubber	5.6	5.8
Textiles	8.5	9.0
Total	**268**	**290**

*U.S. plastics sales were about $2 billion in 1957; total chemical sales were $24.4 billion. Thus any chemical company with more than 8% of its sales from plastics can be considered above the average for the industry. Plastics account for more than 10% of the sales of the German chemical industry.



acf Lubricated Plug Valves give you minimum turbulence ... minimum pressure drop

The shape and size of the rectangular ports of ACF Lubricated Plug Valves combine flow efficiency of the pipe with compact plug valve design.

The flow of fluid from pipe through plug is unimpeded: entrance chamber design reduces turbulence to a minimum, and loss of head pressure is kept to a minimum.

Other advantages: tight sealing without wedging or sticking; Teflon* head gasket; quick quarter-turn opening and closing; precision lubrication; knife-edge shearing action of the plug.

For efficiency, for easy operation, for low maintenance and long life, specify the industry's finest—ACF Lubricated Plug Valves.

*Du Pont's tetrafluoroethylene resin.

On Hand

Order ACF valves from your industrial jobber or supply store. *Sizes:* ½-inch through 30-inch. *Pressures:* 125 lbs. WOG to 500 lbs. WOG in semi-steel. ASA 150 and ASA 300 in carbon steel. Rectangular, round, V and diamond ports. Bronze and aluminum valves available for use where indicated.

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W-K-M's *Creative Engineering* can assist you with any special problem. If it involves flow of fluids or gases through valves, check first with W-K-M.

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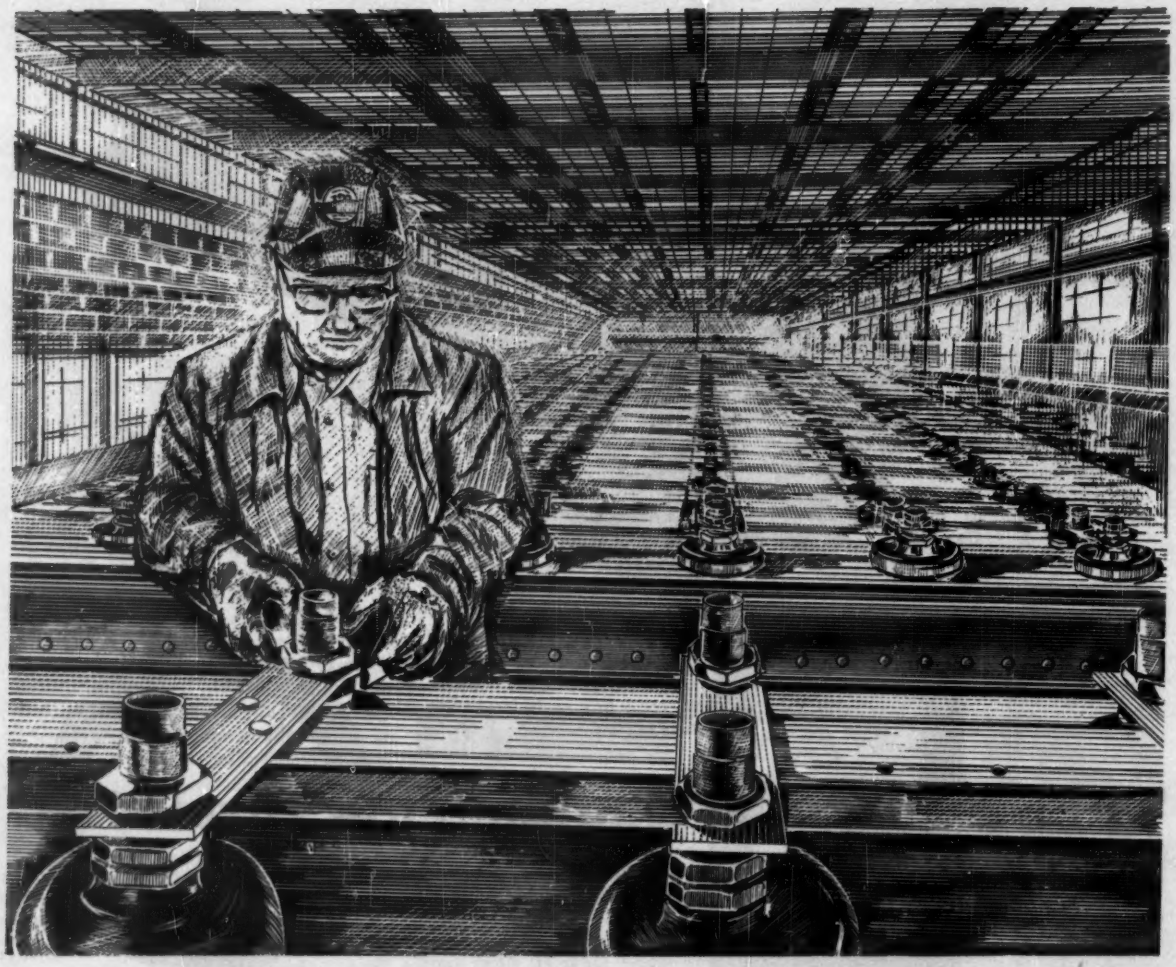

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The quiet efficiency of a skillfully operated cell room has the rewarding effect of extra returns.

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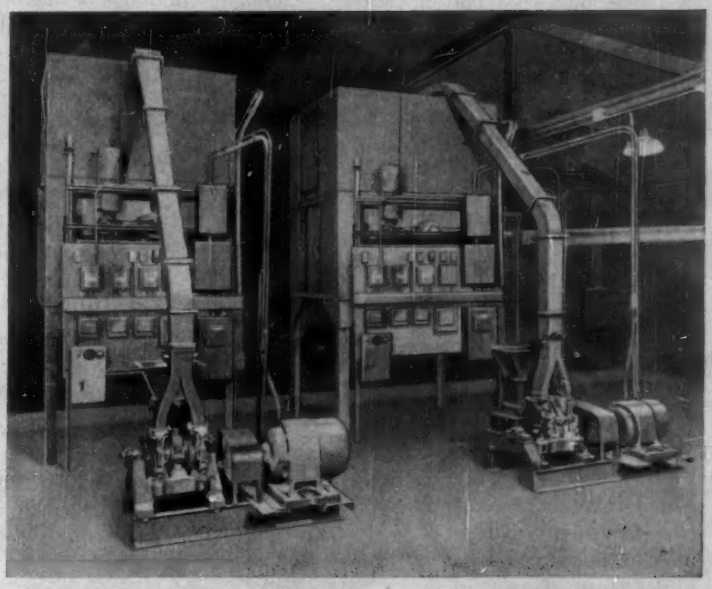
MIKRO-D equipment is designed to help you put new efficiency and economy into whatever products you grind. We'll be glad to make test runs on the unground material and submit recommendations entirely without obligation. Whether your operation calls for a standard unit or a specially-engineered system, MIKRO-D can fill all your grinding and collecting requirements. Complete information available on request.



Installation consisting of two MIKRO-ATOMIZERS, each connected with and discharging to a MIKRO COLLECTOR.

GENUINE MIKRO-D REPLACEMENT PARTS
Available From Large Stock Within 48 Hours.

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Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

BLENDING HCL AND STARCH POWDER

An assembly of horizontal batch mixers preceded by brush sifters had been installed for the mixing of diluted HCL acid and starch powder prior to converting the starch to dextrine. Results indicated quickly that thorough blending was needed.

Non-uniform distribution of acids and starch caused acid-rich nodules on the stock layer to be conveyed to the oven. Other portions were insufficiently treated. Two troubles resulted:

1. Those portions of the stock over-treated either carmelized or charred causing carbon specs.
2. Portions under-treated were not completely dextrinized.

When an adaptioneered S-W Intimate Blending System was installed, acids and starch were so completely blended that both types of troubles were entirely eliminated. Sprout-Waldron blending not only eliminates all lumps or nodules, but accomplishes such complete dispersion that individual particles lose their identity.

SW

STOP DUST WITH S-W MULTI-TUBE FILTER DUST COLLECTORS

Operates under a vacuum so there is no outward leakage
Compact, streamlined appearance
Available for floor hopper mounting
Shaker handle facilitates cleaning of filter tubes
Filter tubes easily removed for inspection
Available in either 200 cfm or 400 cfm capacity

To provide maximum plant cleanliness, prevent waste and eliminate complaints about dust, the Sprout-Waldron multi-tube dust collector is the most efficient answer.

The floor mounted Sprout-Waldron dust collector draws dust in through a connection in the side of the case. The hopper mounted unit utilizes the suction created to draw the dust-laden air from the complete hopper surroundings. A separate air inlet connection in the side of the case may be furnished so the dust from other equipment as well as from the hopper may be collected. Dust cannot leak out of the collector since the entire case is under vacuum during operation.

The clean air from either unit may be discharged directly into the room for conservation of heat or be blown to the outside through ducts when required. Each of the many special cloth filtered tubes have their own support grid and the complete tube assembly can be kept clear of dust for greater filtering efficiency at periodic shaking of the entire support plate.

Close up of Sprout-Waldron Richmond Gyro-Pedestal Sifter showing columnar construction which permits 360° rotation.

GYRO-SIFTERS HELP KEEP ABRASIVE WHEEL QUALITY HIGH

Maintaining uniform grain size in the mass production of resin-bonded abrasive wheels at Carborundum presented quite a problem. Operating sequence called for mixing the various size grains with the resin binder at a central location and then conveying by means of buckets to 86 molding stations. The buckets discharged the grain-resin mixture into surge bins situated over the wheel molding machines.

Troubles arose because the pressure sensitive nature of the resin-bonded granules led to the formation of oversized agglomerates, which had to be screened out or broken up to maintain uniform grain size. A variety of vibrating devices had been tried without success. Carborundum licked the problem by mounting 43 Gyro-Sifters at the discharge ends of the bins. Since the design of these sifters permits them to be rotated 360° this arrangement made it possible to use one sifter for two or more reserve hoppers.

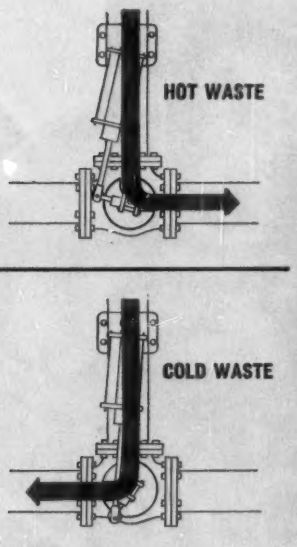
The full story appears in S-W *Pointers*, Vol. 7 No. 3. Copy on request.

CP/105

How would you solve this problem?

Problem: Waste from a process unit varied in temperature with the process cycle. How would you control the waste flow to utilize hot waste and cold waste in heat exchangers in other parts of the plant?

Solution: Rockwell-Nordstrom 3-way Multiport valves (see below) were equipped with thermostatically controlled air cylinder actuators. As the temperature of the waste in the valve inlet line changes, the thermostat "tells" the cylinder to move the valve plug and automatically shunt the hot waste into one inlet line or the cooled waste into the other outlet line. *One valve does the job of at least three!*



Rockwell-Nordstrom Multiport valves are used in the process industries where 3-way and 4-way flow control is needed through one valve. They greatly simplify flow control and reduce cost by eliminating unnecessary piping and valves.

Rockwell-Nordstrom is the world's most complete line of lubricated plug valves—both Multiport and Straightway. Available in semi-steel, steel, stainless, Monel, Bronze and other corrosion-resisting alloys in sizes from ½" to 30" to meet every process valve need. For details, write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

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☐ Please send me complete information on Rockwell-Nordstrom valves for process, industrial and manufacturing flow control.

☐ Please send me the name of your nearest distributor . . . ask him (to) (not to) call immediately.

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"Bimetal Freeze-up" Can Be More Serious Than Dial Fogging Problem

The first sign of moisture in a dial thermometer usually shows up as condensation inside the dial glass. You are probably familiar with this dial fogging problem which causes difficult reading and the eventual corrosion of the bimetallic element. You may not, however, be familiar with another and actually more serious moisture problem —bimetal "freeze-up."

Both dial fogging and bimetal freeze-up are permanently prevented by RMC's dry air hermetic sealing process.

If moisture is sealed in, or enters a thermometer dial it will find its way to the bimetal element. Then at extreme low temperatures this moisture freezes on the element and bearing surfaces, and the bimetal element will not function should the temperature go lower. Therefore, the operator of the equipment would never know that the temperature had gone below the last indication when the element became frozen.

Here's what makes such a condition hard to spot. The thermometer would operate properly again after a temperature rise of perhaps 20°, and would continue accurate indication even though the fluid dropped again to an even lower temperature than before. However, after it remained at the new low for a few hours, it would again freeze up. Then, as before, any further drop in temperature would not be indicated.

Only a dry-air hermetic seal, as used by RMC, can prevent both dial fogging and bimetal freeze-up. RMC even goes a step further by providing for recalibration at any time without breaking the air-tight seal. An external dial reset screw—exclusive with RMC—permits recalibration without opening the instrument in any way.

Industrial Needs Call For Magnetic Liquid Level Gauge

Magnetic drive provides accurate readings with complete safety in all types of liquids under pressure. RMC Magnetic Level Gauges meet requirements of the Underwriters' Laboratories and A.S.M.E. Boiler Code.

Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill provide the answers. Rochester Mfg. Co., 113 Rockwood St., Rochester 10, N. Y.

These RMC thermometers have just been submerged in water for 15 minutes—the first of a series of severe tests given RMC thermometers to make sure hermetic seal is perfect.

We make certain that moisture will never bother your RMC thermometer

The RMC hermetic sealing process makes absolutely certain that humid air will not be sealed in the instrument and locks all moisture out permanently. Each thermometer then goes through a series of severe tests. Only those with perfect sealing are accepted for delivery. When you order from RMC you get the *only* industrial thermometer that can *never* be affected by internal dial fogging or bimetal freeze-up.

RMC

ROCHESTER MANUFACTURING CO., INC.
113 ROCKWOOD STREET • ROCHESTER 10, N.Y.

LIQUID LEVEL TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES

ONE OF A SERIES

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Can Wyandotte technical service create a new product for you?

The answer to this question is "NO."

The reason is obvious.

The primary purpose of Wyandotte technical service is to make specific recommendations as to the best ways and means to use our products . . . not to create new products for you. The expert scientists in your own research and production are best qualified to do this.

This does not mean, however, that we cannot be helpful to you in the development of a new product.

On the contrary, because our technical service is deep-rooted and sincere – and embraces every one at Wyandotte not directly concerned with administration or routine manufacturing – we are ideally equipped to work *with you.*

As a result, such fundamental information as chemical and physical properties, handling and storage practices and precautions, product limitations and other pertinent characteristics are readily accessible to you as a service on Wyandotte products, where they apply. Consultations with science-specialists* on specific areas of a product's application are also available. Application data based on research and industrial experience is obtainable to help you improve your formulations or processes . . . or develop a new product.

So if you have the need for such a service, send us as much data as you can, with the product characteristics you want, and we will be happy to work with you.

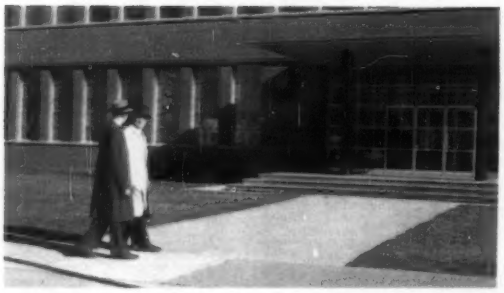
For a pictorial presentation of Wyandotte at work, turn the page.

*Chemists, chemical engineers, physicists, etc., whose industrial or research experience qualifies them as specialists in their particular field.

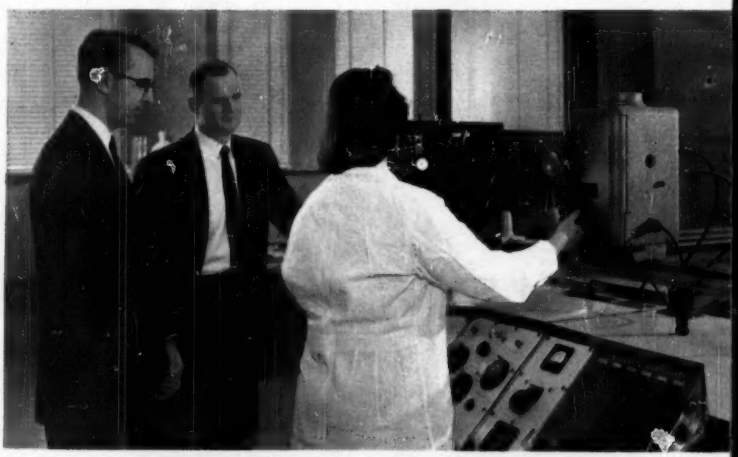
WYANDOTTE CHEMICALS

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE GLYCOLS • SYNTHETIC DETERGENTS (anionic and nonionic) • CARBOSE® (Sodium CMC) • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • PROPYLENE OXIDE • PROPYLENE DICHLORIDE • POLYPROPYLENE GLYCOL • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

Showing the customer what makes our technical service tick



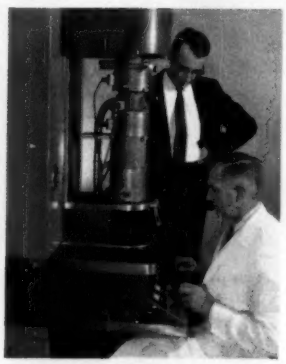
1 You're about to see a revealing demonstration of creative chemistry at work — on a tour of Wyandotte's modern research center with a technical-service representative.



2 In the analytical department, you watch raw-material samples and synthesized compounds coated on carbon electrodes to make spectrogram with emission spectrograph.

3 A versatile Chromotog is at work fathoming the makeup of organic compounds — vaporizing them for analysis and separation; registering the results on a recording chart.

4 You're shown the Wyandotte identification method developed in the physics infrared laboratory for applying IBM punching and sorting techniques to infrared "fingerprints."



5 You see an electron microscope that gives direct magnifications up to 21,000 diameters; displays structural detail for checking particle-size distribution.

6 In the application laboratory, batteries of special equipment test, develop, and improve Wyandotte products; research customer product or processing problems.

7 Research projects begin here, in the research library. Boasting thousands of books and journals, it has facilities for gathering any recorded scientific information.

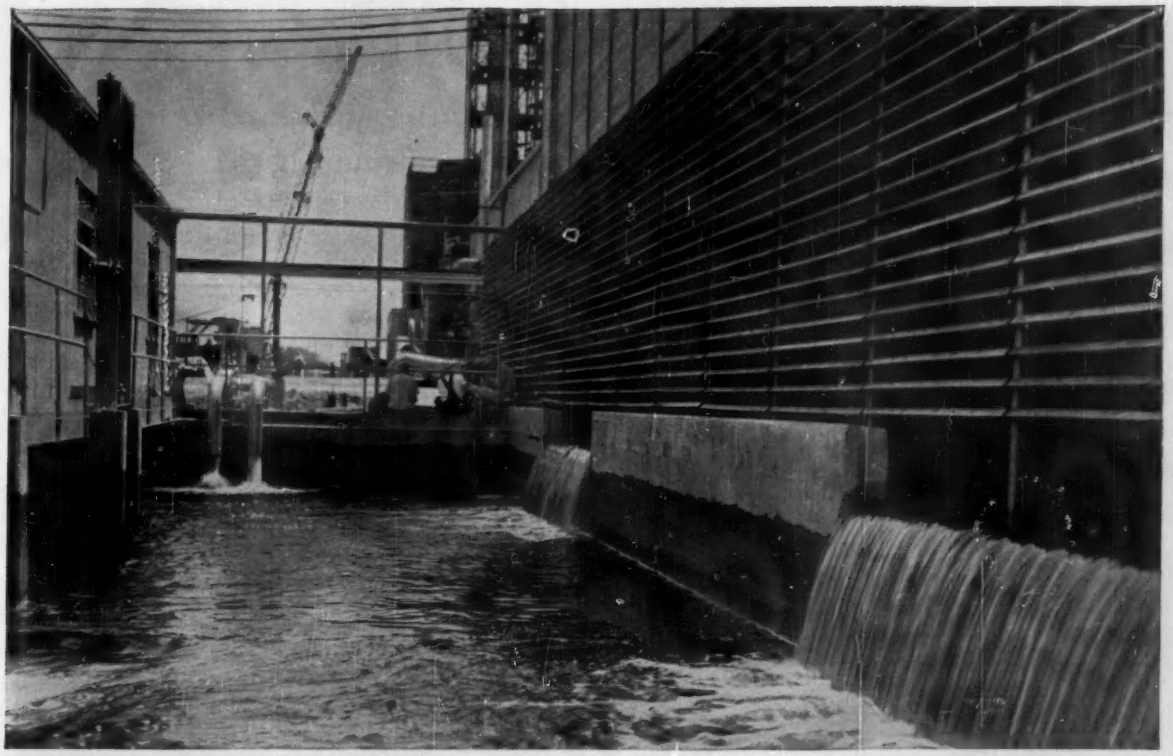
8 You step into a private office to discuss your product or processing problem with the technical-service man . . . knowing that every tool of modern research is at your disposal.

Wyandotte technical service is backed by the most advanced research facilities in the industry . . . where creative chemists are preparing today for the chemical needs of tomorrow. Research-backed technical service is available to all Wyandotte customers and prospects. If you have a problem that falls within our technological or manufacturing background, check with us . . . our approach is designed to provide answers. *Wyandotte Chemicals Corporation, Michigan Alkali Division, Wyandotte, Mich. Offices in principal cities.*

Wyandotte
CHEMICALS

Pacing Progress with Creative Chemistry

532



How you can be sure to get the capacity you pay for in a cooling tower...

Thousands of gallons of water pour through a cooling tower every minute. If it goes in hot and comes out cold . . . if it keeps a plant's process water reasonably cool—is it safe to assume that the tower is doing its job . . . that the owner is getting his money's worth out of it?

Definitely not!

A tower may actually be operating at only a portion of the capacity paid for—without the owner's knowledge. Its heat transfer efficiency may fall short of specifications. Operating horsepower requirements may be higher than they should be.

How can you tell?

By conducting thorough field performance tests. But if the tower proves deficient, you can correct it only by increasing horsepower or the size of the tower—or both. Even though the manufacturer stands behind his product, you are put to additional expense, you may lose valuable production because of down time during the reconstruction, and your operating power costs may be increased for the entire life of the tower.

Obviously, the best thing is to *know* the capacity before you buy.

How? Well, you *can* accept the manufacturer's guarantee. But how many manufacturers *really* know? Determining the capability of a cooling tower is an exacting science, requiring highly specialized knowledge of a wide variety of factors influencing performance.

Portions of such knowledge have been published in the past but much has been retained by cooling tower manufacturers as "private and confidential" data. But now, Pritchard has gathered all this information, refined it, added to it field-tested findings from our own research facilities, and arranged it into usable form. This reservoir of knowledge has been published under the title, "Counterflow Cooling Tower Performance," and is available from Pritchard for $3.00. For your copy, mail the coupon below with your check or money order.

No book alone, however, can guarantee cooling tower capacity. That is the responsibility of experienced Pritchard engineers, who translate the information contained in the handbook into cooling tower designs that give you performance, not promises . . . real long-run economy, not first-cost-only economy.

The result is that when you buy from Pritchard, you buy with full confidence that you get what you pay for. You can rest assured that your Pritchard tower will deliver the capacity you specify.

J. F. PRITCHARD & CO. OF CALIFORNIA

Dept. 101, 4625 Roanoke Parkway, Kansas City 12, Mo.

- ☐ Enclosed is $3.00. Please send copy of "Counterflow Cooling Tower Performance"
- ☐ Please send free copy of new Counterflow Cooling Tower Bulletin 4.9.080A
- ☐ Please have your representative call on me

Name..... Title.....

Firm.....

Address.....

City..... Zone..... State.....

Trapping Standardization

. . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

4. You can enjoy the advantages of standardized hook-ups.

Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how

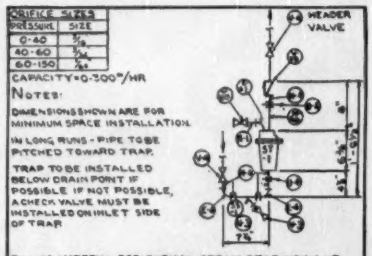


Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.

2. Strainer ahead of trap protects it against dirt and scale.

3. Blowdown valve in strainer provides easy cleaning.

4. Check valve in discharge line isolates trap when test valve is opened.

5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

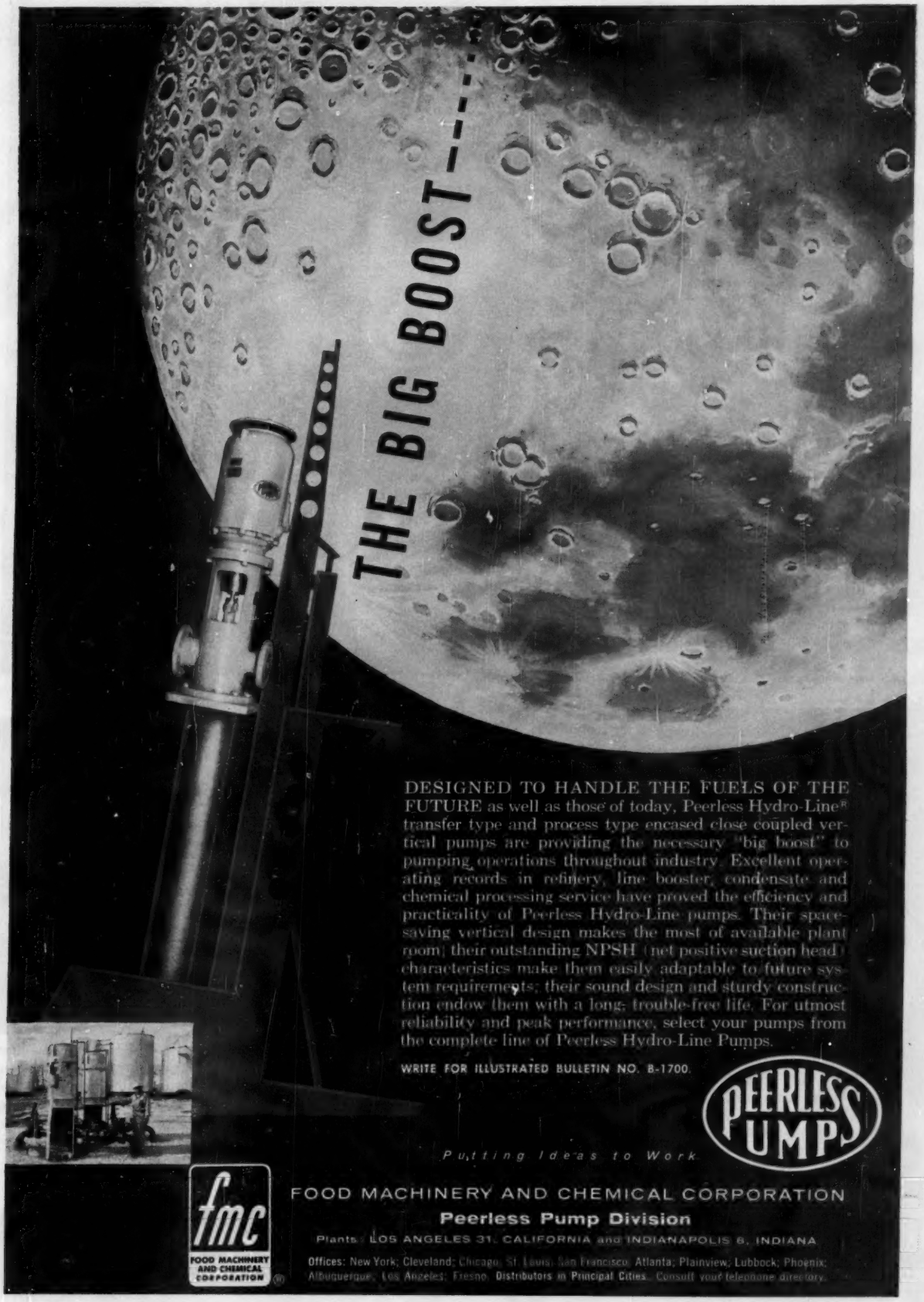
3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8584 Maple St., Three Rivers, Michigan.**

ARMSTRONG STEAM TRAPS



DESIGNED TO HANDLE THE FUELS OF THE FUTURE as well as those of today, Peerless Hydro-Line® transfer type and process type encased close coupled vertical pumps are providing the necessary "big boost" to pumping operations throughout industry. Excellent operating records in refinery, line booster, condensate and chemical processing service have proved the efficiency and practicality of Peerless Hydro-Line pumps. Their space-saving vertical design makes the most of available plant room; their outstanding NPSH (net positive suction head) characteristics make them easily adaptable to future system requirements; their sound design and sturdy construction endow them with a long, trouble-free life. For utmost reliability and peak performance, select your pumps from the complete line of Peerless Hydro-Line Pumps.

WRITE FOR ILLUSTRATED BULLETIN NO. B-1700.

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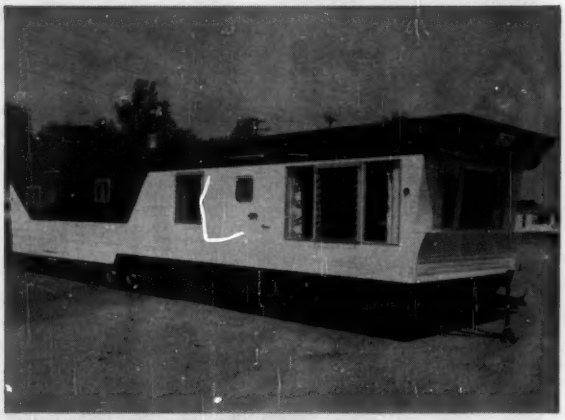
HOW HERCULES HELPS...

REVOLUTIONIZE HOSPITAL WARE—Zylon Products Company's new plastic hospital utensils molded with Pro-fax*, Hercules polypropylene, cost much less than existing equipment, provide added comfort and convenience for patients and staff. Colorful, lightweight, and easy to handle, they can be steam-sterilized, will resist stains, chemicals and saline solutions.

**Hercules Trademark*

REVOLUTIONIZE RESTAURANT MENUS—Meat processors can now offer succulent steaks at budget prices. Portion steaks cut from utility or commercial beef are easily tenderized with Age-It®, Hercules' "dip, drain, and freeze" liquid tenderizer. Hercules also produces MSG, monosodium glutamate, and HVP, hydrolyzed vegetable protein.



REVOLUTIONIZE TRAILERS—Mid-States Corporation's two-tone Mobile Homes are not only gay, but they are weather-defying, too, because they are finished with Parlon®-fortified enamels supplied by Capitol Chemical Company, Chicago. Parlon adds both durability and drying speed. Mid-States gains fast taping, 45-minute recoating, and dust-free surfaces for outside storage within three-quarters of an hour.

GSE-4

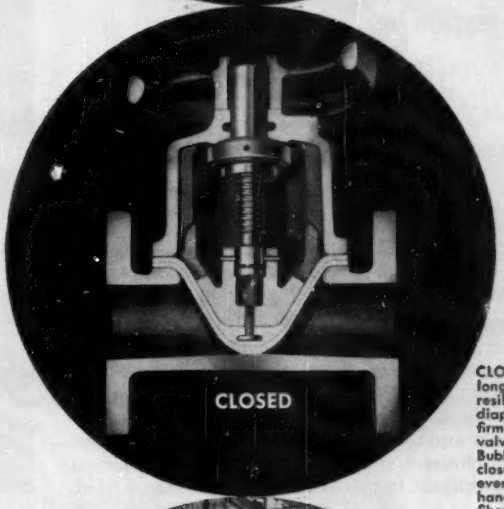
HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

CHEMICAL MATERIALS FOR INDUSTRY

HERCULES

Maximum flow, minimum turbulence, negligible pressure drop!

OPEN Diaphragm lifts high for streamline flow. Also, valve design permits comparatively simple radding through, when necessary.



CLOSED Despite long usage, resilient diaphragm seals firmly against valve body. Bubble-tight closure is assured, even when handling gritty or fibrous materials.

GRINNELL-SAUNDERS STRAIGHTWAY DIAPHRAGM VALVES* are unsurpassed for handling viscous materials — semifluid foods, latex, magmas; solids in suspension — slurries, pulp stock, sludges; fluid-borne abrasives; corrosive chemicals.

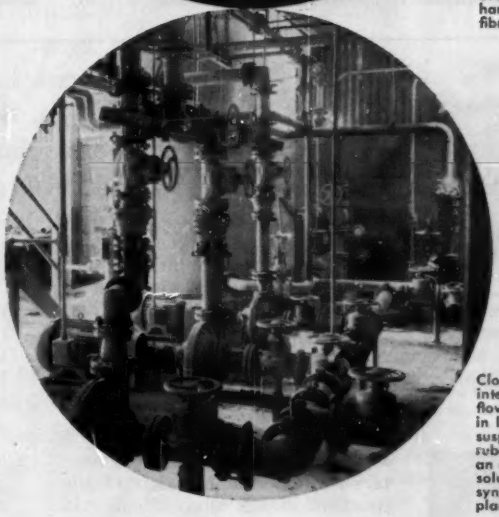
The straight-through design eliminates pockets, gate trenches and other obstructions which can trap solids. The result is maximum flow, minimum turbulence, and negligible pressure drop for a diaphragm valve.

The straight-through design also has the advantage of causing very little basic change in the direction of the fluid stream, thus reducing abrasive action from high velocity particles.

These advantages are in addition, of course, to benefits normally associated with the use of diaphragm valves . . . such as freedom from corrosion and clogging of working parts, since these are completely sealed off by the diaphragm; prevention of product contamination; elimination of stem leakage and routine maintenance, because there are no packing glands. Also, when properly pitched, lines are self-draining.

Grinnell-Saunders Straightway Diaphragm Valves are available in a choice of body sizes and materials, linings and diaphragms. Handwheel or power operated. For complete information, write Grinnell Company, Inc., 277 West Exchange St., Prov. 1, R. I.

*Patented



Clogging and interruption to flow is prevented in lines handling a suspension of rubber particles in an acid brine solution at this synthetic rubber plant.

GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

News and Notes on...

Good Packing Practice

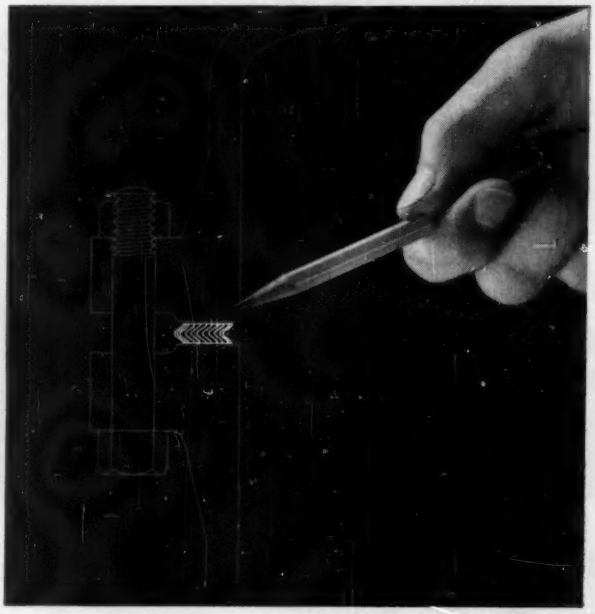
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: Selecting the Gasket

Question:

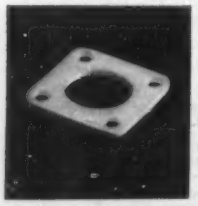
What are the important points to remember about gasket applications so we can avoid costly failure?



GASKET engineering is a complex study, but there are certain simple answers to this commonly asked question. Briefly, at least three variables must be considered. These are: 1. The available bolt force on the gasket. 2. Internal pressure and temperature. 3. The nature of the contained fluid.

Starting with bolt force: it must be adequate to flow the gasket material and cause it to yield and seat effectively. Secondly: the bolt force must also always be sufficient to exceed the internal pressure and temperature forces that work against gasket closures. Finally: the gasket material must be impervious to the action of the confined fluid.

For service at low to medium temperatures and pressures: As a rule of thumb, if multiplying the operating pressure (psi) by operating temperature (°F) results in a product not exceeding 250,000, a quality "general service" type gasket can be used with complete safety. An outstanding gasket material for these operating conditions is J-M Service® Sheet #60 . . . a tough, durable compressed asbestos sheet. Service Sheet seals effectively against hot or cold water, steam, oils, mild acids and caustics.



If corrosive fluids are encountered: The best solution to the constant attack of chemicals and solvents is a gasketing material that is chemically inert. For this kind of service condition, Johns-Manville Teflon* Chempac® Gaskets are recommended. They are available in pure Teflon, low-flow Teflon-Asbestos, and in metal-(glass-filled) Teflon, Teflon combinations.

*TM for DuPont Tetrafluorethylene resin.

When extreme pressures and temperatures act on the gasket: If internal pressures reach 1200 psi or temperatures exceed 850°F, safe practice calls for a sturdy gasket that offers the high resiliency needed to follow expanding and contracting movements of flanges. For standard flange applications to 6,000 psi, you will find metal-asbestos, spiral-wound Goetze Spirotallic® gaskets most efficient. They offer high mechanical strength and resilience. Their special interlocking design and stainless steel construction is especially designed to effect and maintain a tight seal despite wide pressure and temperature variations.

To solve any sealing problems, call your J-M Packings and Gaskets field representative. He's equipped to give you information on new products . . . engineering and design advice. For information on any J-M Packings or Gaskets write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

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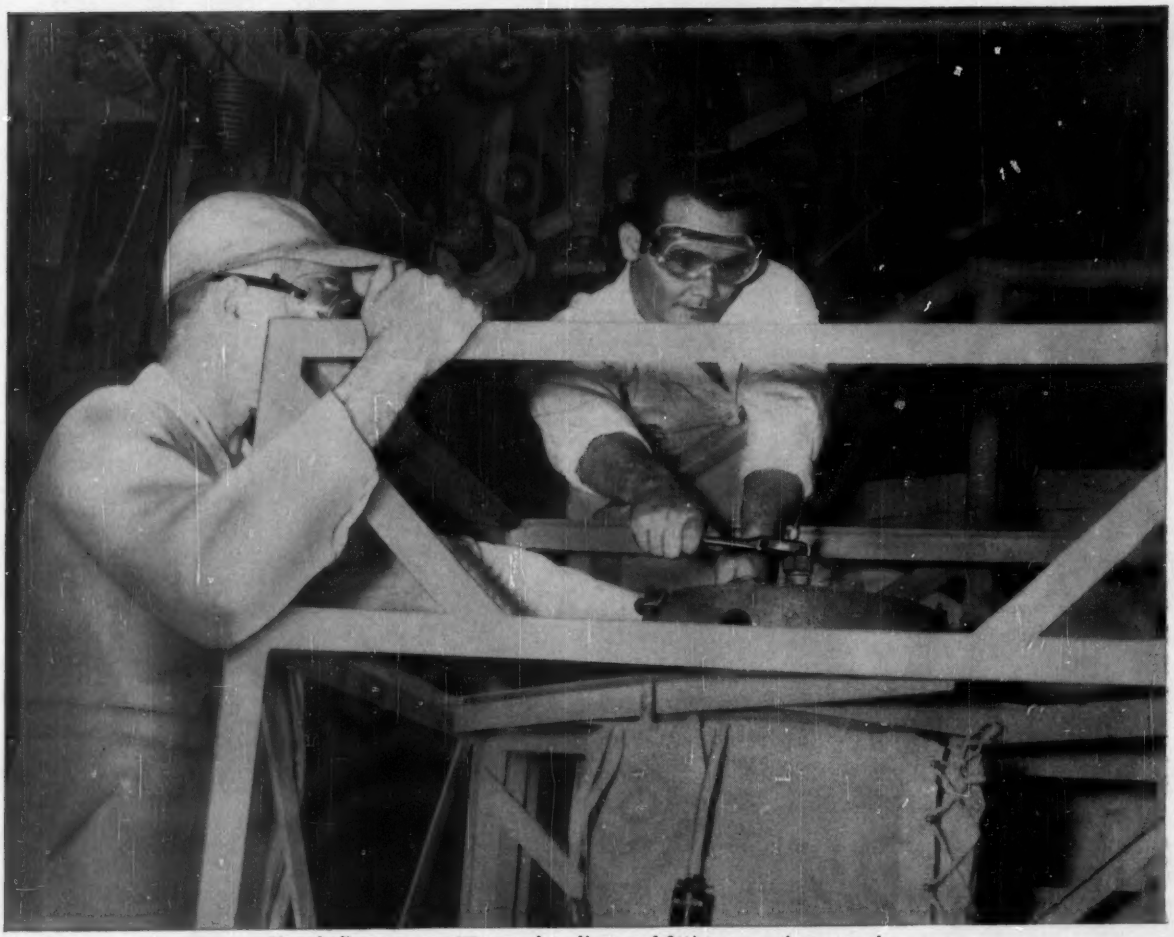


Monel alloy counters UF_6 attack on lines and fittings carrying corrosive

Two Inco Nickel Alloys lengthen life of equipment processing nuclear fuels commercially

Mallinckrodt Chemical Works produces reactor fuels of uranium dioxide and other uranium compounds on a commercial basis at Hematite, Missouri. Enrichment of these uranium products ranges from less than 1% U-235 to more than 90%.

The products are derived from UF_6 liquefied gas . . . hydrolyzed, precipitated as ammonium diuranate and dried to produce U_3O_8.

To withstand attack by the highly corrosive UF_6, Monel* nickel-copper alloy lines carry gas from container to hydrolysis.

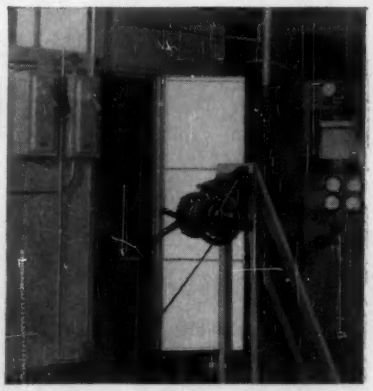
In further processing, batches of U_3O_8 are fired in cracked ammonia atmospheres at 1500° to make UO_2, suitable for use in pellet fuels. (A sintered material for use in matrix-type fuel elements is also made.)

Inconel* nickel-chromium alloy trays and fixtures successfully endure the severe heat and corrosive atmospheres in the furnace.

Both Inco Nickel Alloys are extensively used for other corrosion- and heat-resisting equipment producing and concentrating uranium and uranium fuel materials. The Development and Research Division of Inco has helped solve many metal problems in this design area. They can probably help with yours . . . if you say the word.

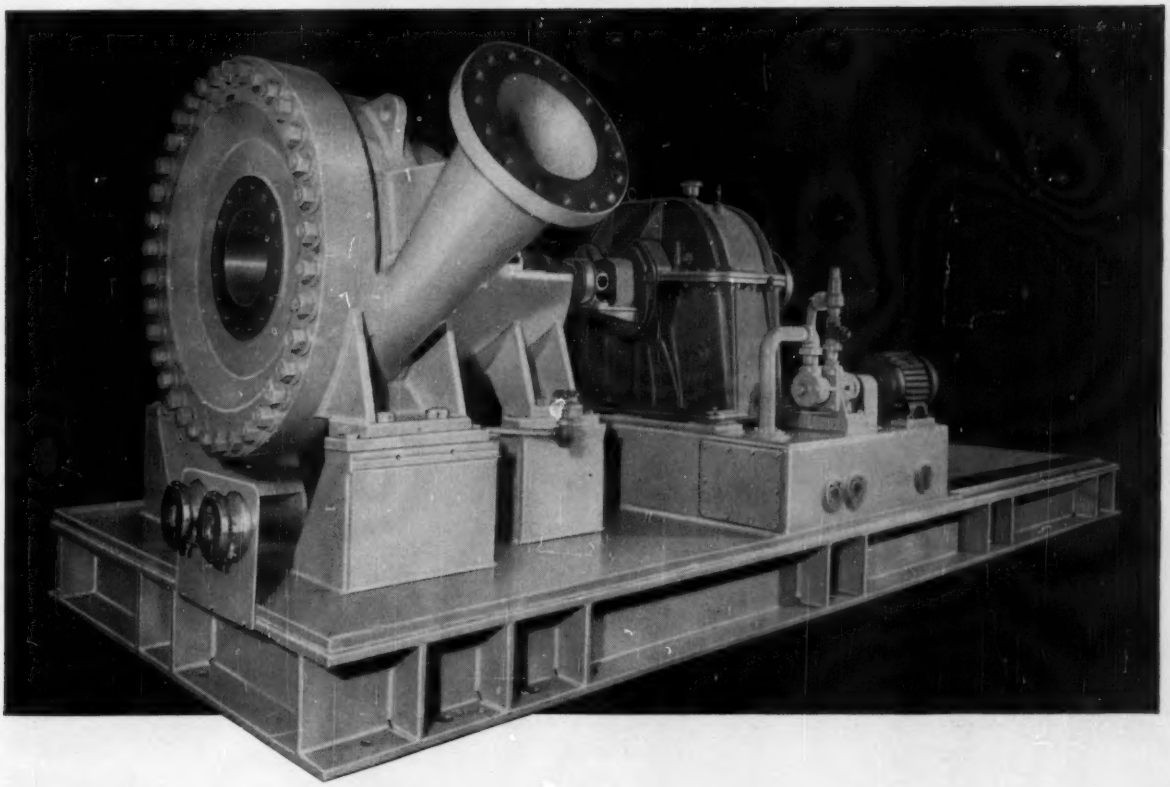
*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street — New York 5, N. Y.



Inconel alloy reduces oxidation damage to batch trays and fixtures in 1500°F converting furnaces

INCO NICKEL ALLOYS



NEW

Single-Stage Barrel-Type
Allis-Chalmers Compressor

Boosts High Pressure Gas to Higher Pressure Levels in Range of 50 to 500 psia.

THIS new Allis-Chalmers development extends the range of single-stage compressors into high pressure levels previously handled by reciprocating type units.

The new compressor has all the advantages of a centrifugal compressor — compactness, pulsation-free operation, few wearing parts, easy maintenance.

The unit shown above, now in successful operation, boosts 3690 cfm of air from an inlet pressure of 185 psia to a discharge pressure of 240 psia. It is driven through a speed-up gear by an Allis-Chalmers 1250-hp motor.

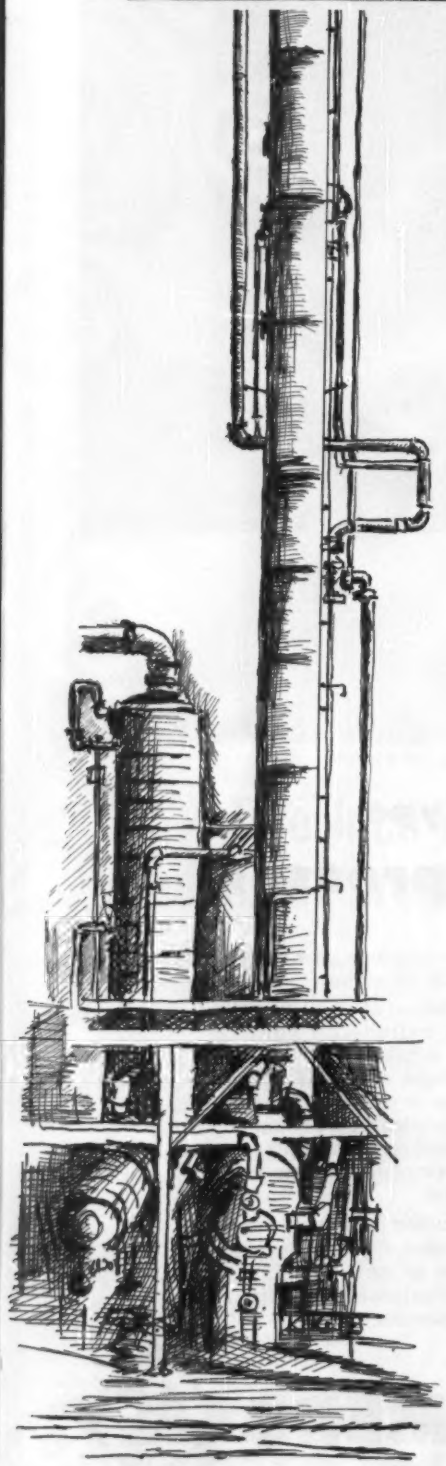
The casing consists of three principal parts: the casing cylinder, a bolted casing head and a fabricated casing pedestal. A diaphragm which forms the gas diffuser passage is inserted into the casing cylinder. Excellent gas sealing is assured, since there is only one shaft extension and only one casing joint to seal against gas pressure.

For details, including a sectional view of this new compressor, call your nearby A-C representative, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5728



Distillation with aniline breaks hydrazine-water azeotrope, keys production of anhydrous hydrazine.

Hydrazine Via NH_3 Today

Improved ammonia-oxidation route links two continuous-reaction processes to win hydrated and anhydrous products.

Commercial production of hydrazine via ammonia oxidation is one of those not-so-young processes that has only recently grown to maturity.

Now, with ample process details just available, Olin Mathieson's hydrazine plant at Lake Charles, La., stands out as a well-seasoned version of this route.

One of the outstanding process highlights is OM's use of azeotropic distillation, with aniline as entrainer, to win commercial quantities of anhydrous hydrazine—now in growing demand for rocket fuels and other uses.

▶ **It Looks Easy, But**—Essentially, OM's route starts with continuous chlorination of caustic soda. Then, in two steps, hypochlorite reacts with excess ammonia, first forming chloramine (NH_2Cl), then hydrazine (N_2H_4). Excess ammonia is removed by distillation, then compressed, liquefied and recycled.

Simple as the route may seem, cautions OM, it teeters on a fine edge of process economics which have to be honed to a sharp optimum. And the company supplies a wealth of evidence to prove that this is just the case at Lake Charles.

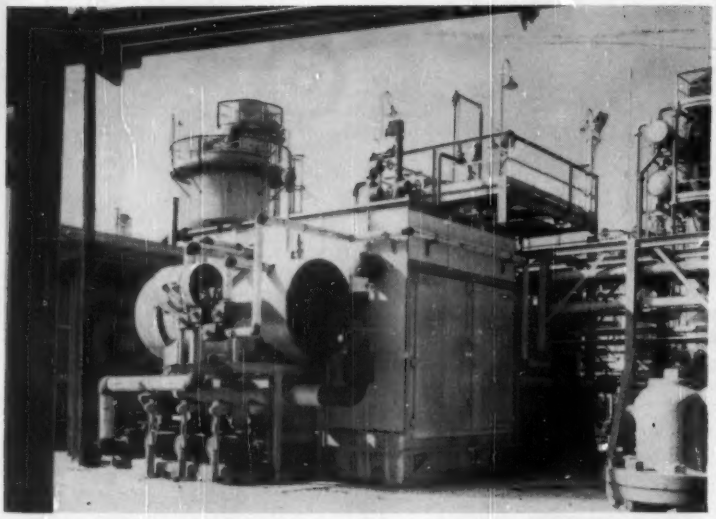
▶ **Why Distillation?** — Azeotropic distillation is one of the latest twists in anhydrous hydrazine manufacture.

Although there are several methods by which hydrazine hydrate may be processed to yield the anhydrous product, OM after extensive investigation decided that distillation had the economic edge.

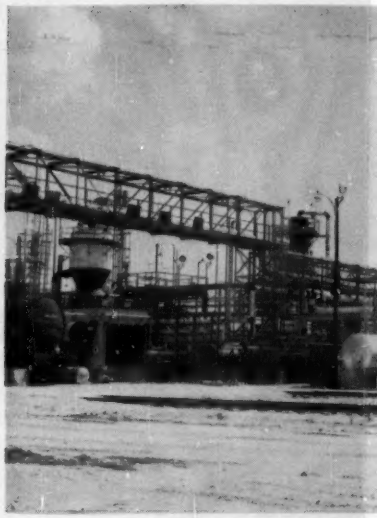
While the company does not state why this is so, it points out that other methods require substantial quantities of reagents or involve techniques such as reduced pressure which entail critical problems of maintaining a tight system. And, significantly, it explains that process losses of N_2H_4 are by far the largest item in cost of anhydrous production.

▶ **NaOH Poses Problems**—Of two commercially attractive dehydra-

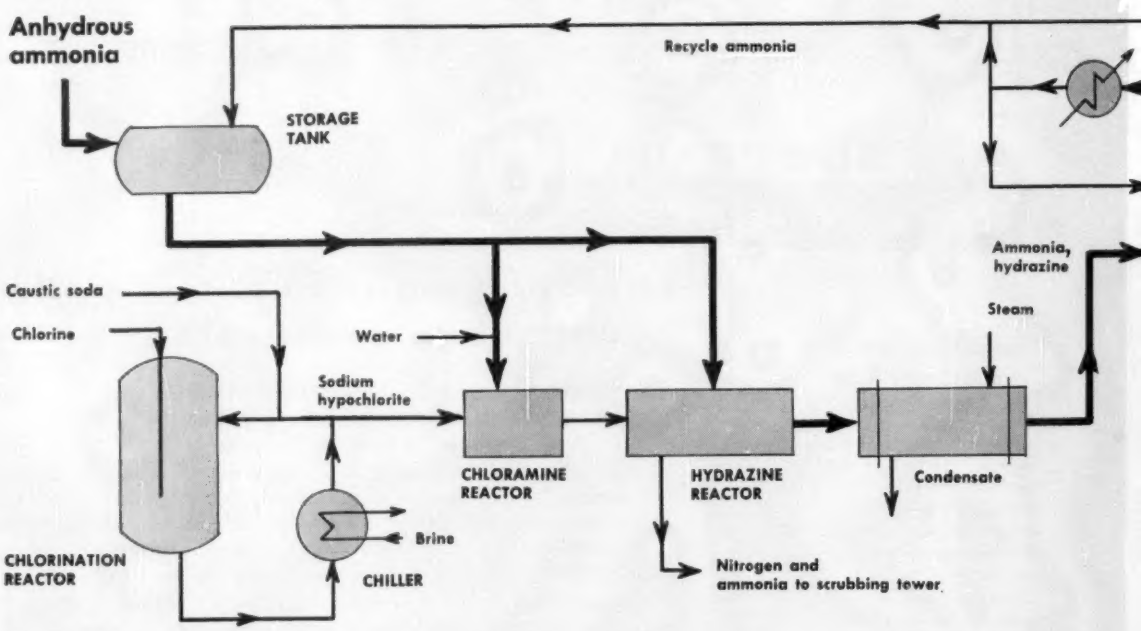
Unfold Flowsheet



CHLORINATION REACTOR gives a continuous supply of sodium hypochlorite; oxidation potential of recirculating solution monitors chlorine.



REFRIGERATION EQUIPMENT house brine system to help control temperature



tion routes, use of sodium hydroxide is less attractive than azeotropic distillation with aniline. OM gives the following reasons for choosing the latter:

In caustic dehydration, it's best to operate at below-atmospheric pressure and lower distillation temperature, thus minimizing hydrazine decomposition.

Low-pressure operation, however, runs the risk of air leakage and consequent decompositions in the system. Too, highly concentrated sodium hydroxide corrodes stainless steel equipment.

Advantages of aniline, OM points out, are low cost, ready availability and complete stability under dehydrating conditions.

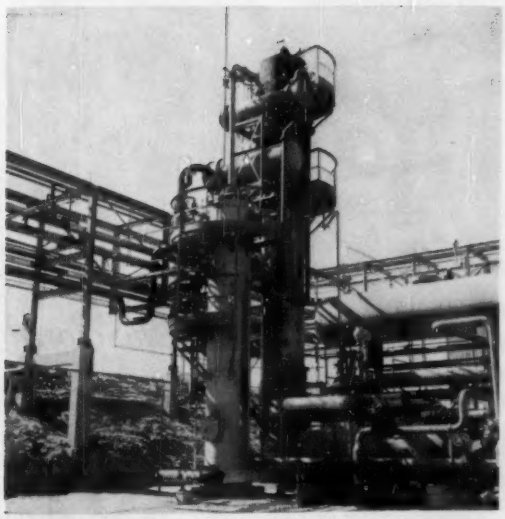
▶ **Two-Step Is Key**—In contrast to the one-step addition of aqueous ammonia used in earlier hydrazine, processes, OM's basic reaction involves adding first aqueous, then anhydrous, ammonia.

In this way, hydrazine in the synthesis stream is made in much higher concentrations, since the large ammonia excess is added independently of diluent water.

Yield of hydrazine (based on chloramine) is about 70% in either case, but higher concentration of hydrazine pays off in operating flexibility.

▶ **Knife-Edge Balance**—Economics are influenced by a combination of variables, such as raw material cost, utilities consumption, concentration of reactants, labor and fixed charges for plant investment.

NT housed in this building uses ammonia-
nperature of chlorination reaction.



AMMONIA RECOVERY COLUMNS strip excess ammonia from hydrazine reaction products.

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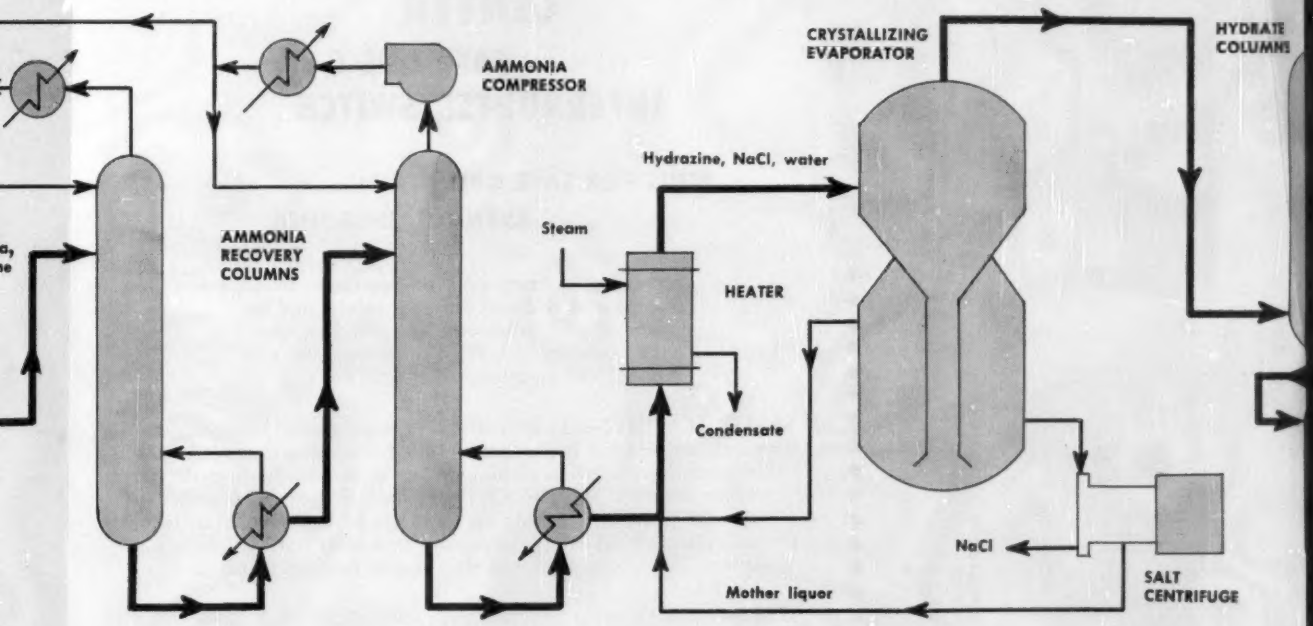

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In hydrazine manufacture, synthesis efficiency is very sensitive to the influence of concentration of reactants. For example, the more dilute the synthesis stream, the higher the hydrazine yield, but utility costs and fixed charges increase with respect to final cost of product. Conversely, somewhat higher capacities may be achieved at the sacrifice of raw materials cost and synthesis efficiency. OM achieves optimum results through design flexibility of the equipment and careful regulation of variables.

▶ **Process Flow**—At Lake Charles, here's how the process works.

Precooled NaOH and chlorine are added to a recirculating solution of sodium hypochlorite and residual sodium hydroxide in a rubber-lined steel vessel. Flow of chlorine is controlled by oxidation potential of recirculating stream (*Chem. Eng.*, Mar. 1954, pp. 128-130).

Residual NaOH leaving the chlorinator is held below 1 g./l. to avoid crystallization problems in the evaporator. And because of low NaOH content, temperature of hypo solution is kept below 30 C. to prevent sodium hypochlorite decomposition.

▶ **Making Chloramine** — A 5-15% (by weight) solution of ammonia (containing about 250 mg./l. of glue to inhibit eventual hydrazine decomposition) is mixed with hypo solution to form chloramine. At this point, mole ratio of ammonia to hypo is about 3 to 1.

Anhydrous ammonia, immediately injected into the chloramine

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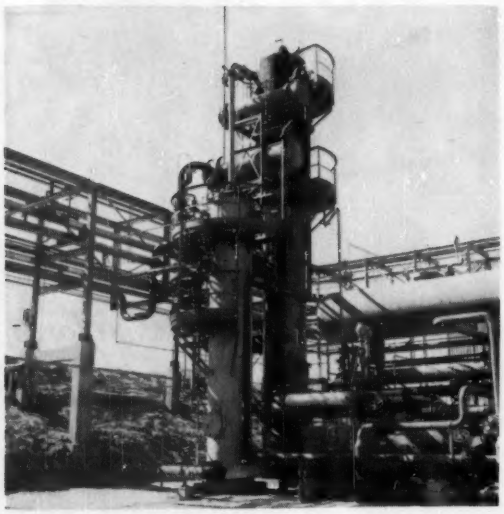

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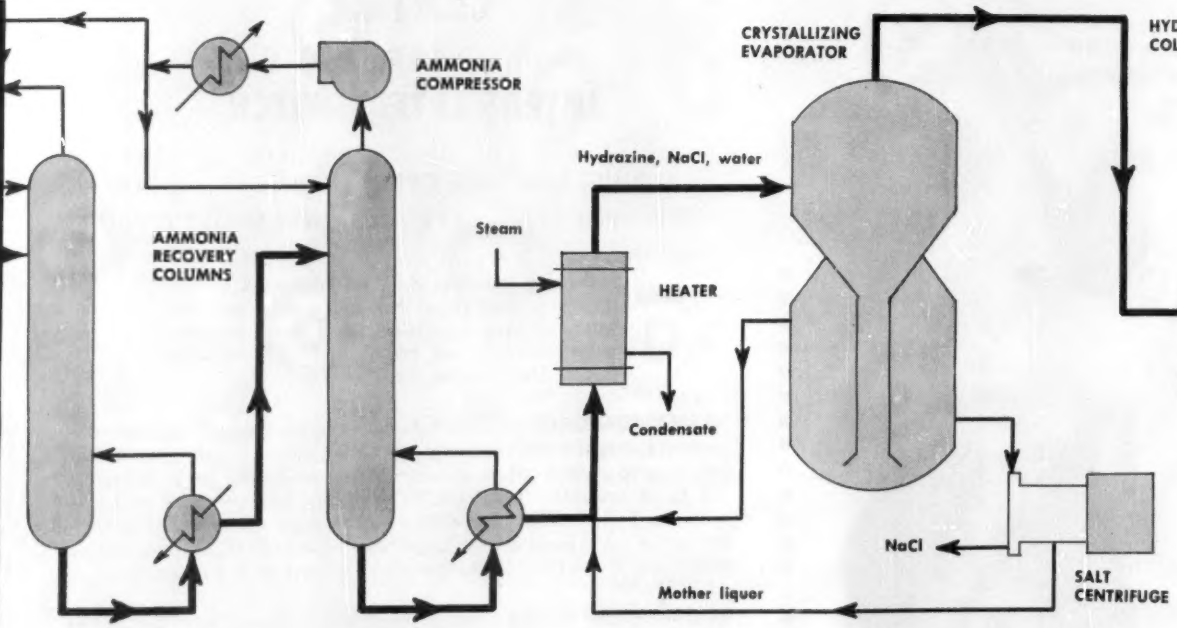

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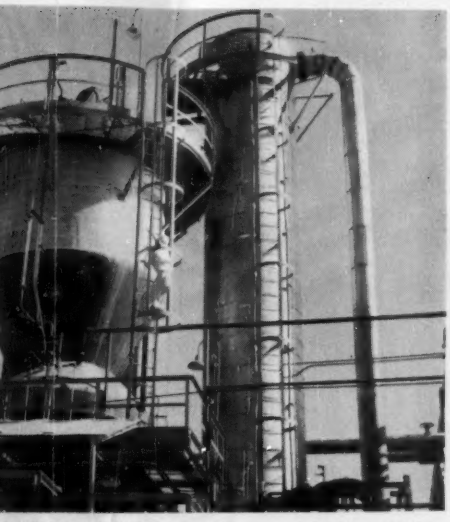
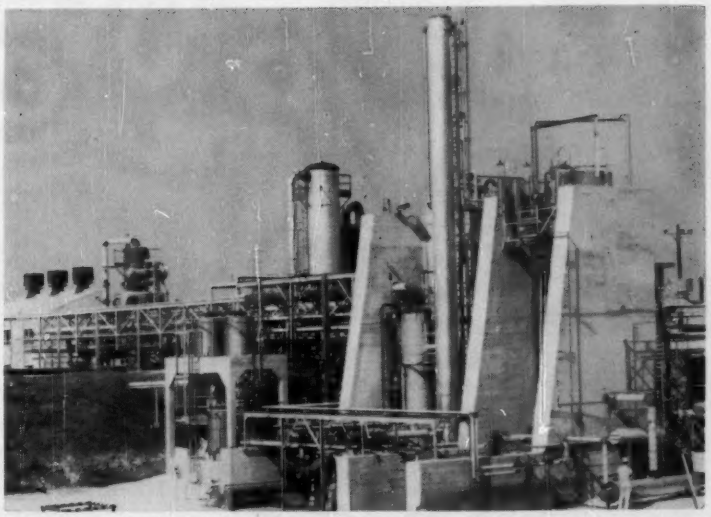
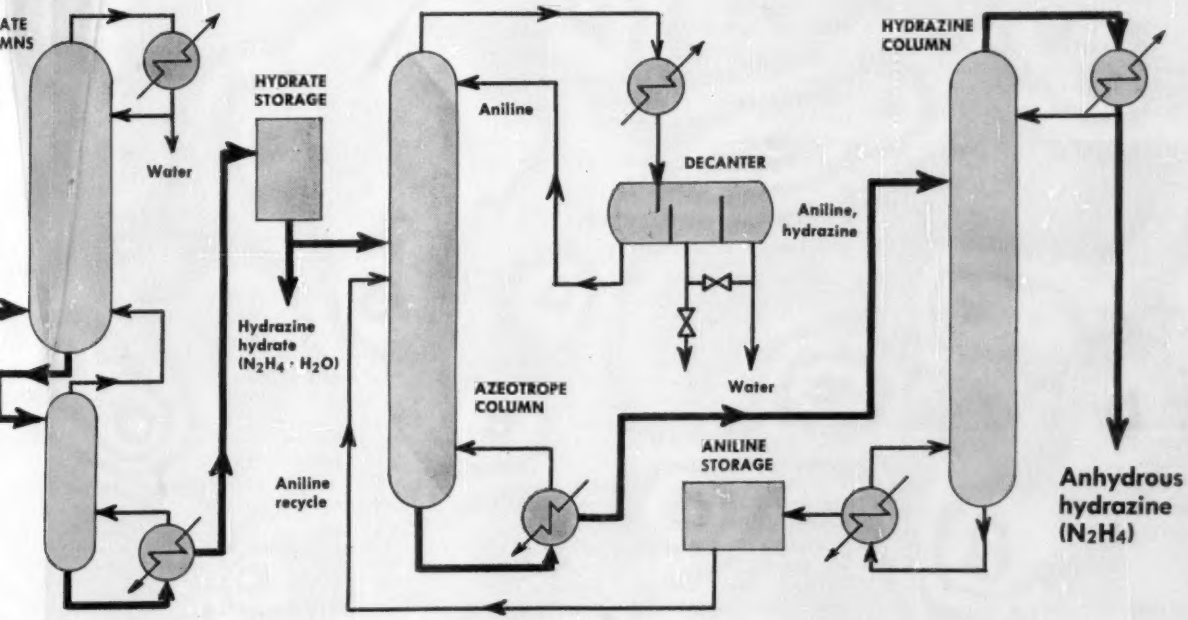


RATOR takes bottoms from ammonia-recovery drazine mixture to hydrate column.



AZEOTROPE COLUMN, center, breaks water-hydrazine azeotrope, routes bottoms to hydrazine column (right), finishing hydrazine to 98+%.



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solution, hikes ammonia-to-hypo mole ratio to about 20-30 to 1 and instantly heats reactants to about 130 C., an ideal temperature for high yields of hydrazine. Reactor pressure must be high enough to keep ammonia in the liquid phase.

▶**Ammonia Recycle** — Synthesis liquor, after going through heater to complete reaction, runs to ammonia recovery columns, where ammonia is separated and routed to liquefaction and recycle.

Sodium chloride is removed from the reaction stream in a stainless steel crystallizing evaporator. Overhead vapors, containing hydrazine, are fractionated in a bubble-tray column, giving bottoms of hydrazine hydrate (up to 65% by weight of hydrazine).

▶**Breaking Azeotrope**—For anhydrous production, the hydrazine-water azeotrope is fed along with aniline to a distillation column which takes the water overhead as an aniline-water azeotrope. Water is easily separated in a decanter, and the aniline is returned to the column.

Bottoms, containing aniline and hydrazine, are then routed to the finishing column for fractionatior to 98+% hydrazine product.

OM is careful to operate the bottom of the azeotrope column at water-free conditions. This is to avoid carrying over low-boiling aniline-water azeotrope into the finishing column, where it would contaminate anhydrous hydrazine product.

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Aluminum Chloride
Potassium Chlorate
Phosphorus Pentasulfide
Benzoyl Chloride

Why we air-condition aluminum chloride. Ever notice how aluminum chloride kicks up in rainy weather?

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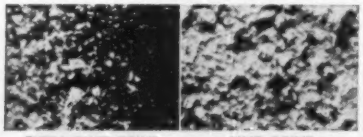
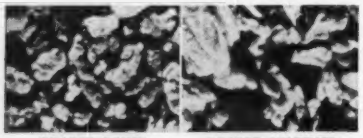
Air conditioning came to the rescue. Now we can make aluminum chloride, anhyd., all year long in a controlled dry atmosphere—so you can always get it at full strength, come rain or shine.



EXTRA FINE GRIND FINE GRIND



COARSE GRIND COARSE SCREENED

You can get Hooker aluminum chloride in any of the four sizes shown here. For technical data, just check the coupon.

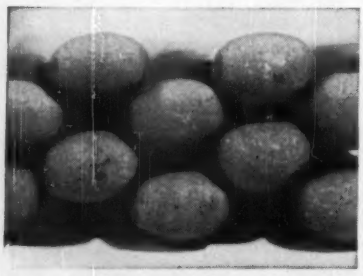
Specialization: extreme case

Maybe the point of this piece is that you never know how a Hooker chemical can help you—until you try it.

At any rate, we've just published new data sheets on two products you'll probably *never* buy. They're very useful, but very specialized.

One of them is Hooker *potassium chlorate*. There's a little of it in the heads of three out of every five safety matches made in this country.

The other is Hooker *potassium perchlorate*. Even more exclusive, it goes almost entirely into railway fusees and fireworks.



How our specialization can help you

Perhaps *your* need for a chemical is as specialized as this. Perhaps our new, wider diversity includes an *existing* product or process that can help you meet this need.

To find out, why not ask us?

Phosphorus pentasulfide: old horse, new blanket

Combine elemental phosphorus with sulfur—as we have been doing for more than 50 years—and you get some interesting results.

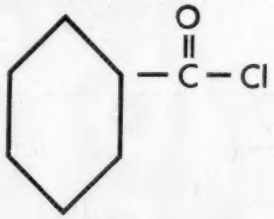
One of them is *phosphorus pentasulfide*, P_2S_5. This chemical was first developed in this country to make flotation reagents for copper ore. A considerable volume of it goes into special motor oil additives.

Most recently, it is helping to raise the curtain on a new field of synthesis—phosphorus-containing insecticides.

To assure good supply and fast service, we make phosphorus pentasulfide in two plants—at Niagara Falls, N. Y., and Columbus, Miss. It's available as powder in three different particle sizes, and as a fused solid. Phosphorus content is 27.8% minimum.

For current technical data sheet, check the coupon.

Benzoyl chloride—99% pure available in large quantities



If you ever have need for a highly pure source of benzoyl groups, our data sheet on Hooker benzoyl chloride will delight you.

Ours is a clear, colorless liquid that assays 99% pure benzoyl chloride on a hydrolyzable chlorine basis.

It makes a fine carrier of the benzoyl group for Friedel-Crafts reactions* and as an intermediate for such chemicals as benzoyl peroxide, benzophenone, and benzyl benzoate.

You can get it in five- and thirteen-gallon carboys and in 55-gallon nickel or lacquer-lined steel drums.

**For Friedel-Crafts reactions we offer a large group of chloro aromatics, some of them mentioned below in the coupon, and aluminum chloride for catalytic use.*

Check the coupon for data.

For more information on chemicals mentioned on this page, check here:

- ☐ Aluminum Chloride
- ☐ Potassium Chlorate
- ☐ Potassium Perchlorate
- ☐ Phosphorus Pentasulfide
- ☐ Benzoyl Chloride
- ☐ Benzyl Chloride
- ☐ *meta*-Nitrobenzoyl Chloride
- ☐ *para*-Nitrobenzoyl Chloride

HOOKER CHEMICAL CORPORATION
407 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

Sales Offices: Chicago Los Angeles New York Niagara Falls Philadelphia Tacoma Worcester, Mass.
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He's not worried...

it's an

R&IE POWER SWITCHING CENTER

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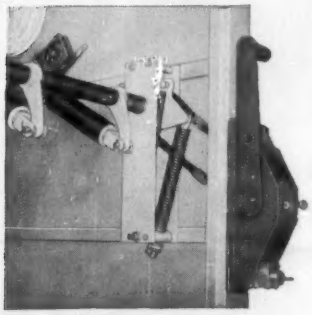
BUILT FOR SAFE OPERATION—
EVEN AGAINST SHORT CIRCUITS

Some day you may close an interrupter switch against a short circuit. For your safety, and the safety of your equipment, be sure your interrupter switches are HPL-C and operate with TOG-L SNAP mechanisms.



TOG-L SNAP—The high velocity blade operating mechanism. Optional, and important to safe closing-in operation.

RATINGS—Fused HPL-C Interrupters
Up to 14.4 Kv (110 BIL)
400 Amperes—(40,000 Amp. Mom.)
1200 Amperes—(60,000 Amp. Mom.)

SAFETY FEATURES—(1) HPL-C closes in on special heavy closing contacts, outside the interrupter—thus preventing damage to the interrupter switch when closing in on moderate fault currents; (2) High velocity "OVR-CENTR" blade closing (and opening) with the TOG-L SNAP operating mechanism—an optional feature, providing additional safety, important especially during the closing operation. For safety sake, specify these important features.

TESTS—Actual closing against moderate 3-phase fault currents at 4.8 and 13.8 Kv has proven that the HPL-C offers this protective feature. Ask the I-T-E Representative to give you the complete facts and details. They will show real economies on installation, operation and maintenance.

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I-T-E CIRCUIT BREAKER CO.
GREENSBURG, PA.

HPL-1

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- *Time Master® control for automatic batching, charging, addition of liquids, discharge and recycle.*
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Speed is profit these days, and it follows that the more continuous you can make your processing — the more continuous can be your profit . . . *sometimes!*

If you've had experience with continuous mixing you may have found that speed was gained *at a loss* in quality, at a high cost in equipment. That's why the Simpson Mix-Muller is designed to combine the distinct advantages of batch mixing with complete adaptability and flexibility for use in continuous processing.

Your National Engineer can help you profit from the experience of hundreds of successful blending operations . . . Installations where the Simpson Mix-Muller is assuring high quality, intimate mixing and effective arrangement of equipment insures continuous *positive* flow of materials to continuous operations such as extruding, briquetting, pressing, tabletting, drying, etc. Write today for details and remember:

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Practice

JULY 14, 1958

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Is your planning up to space-age speeds?..... 155

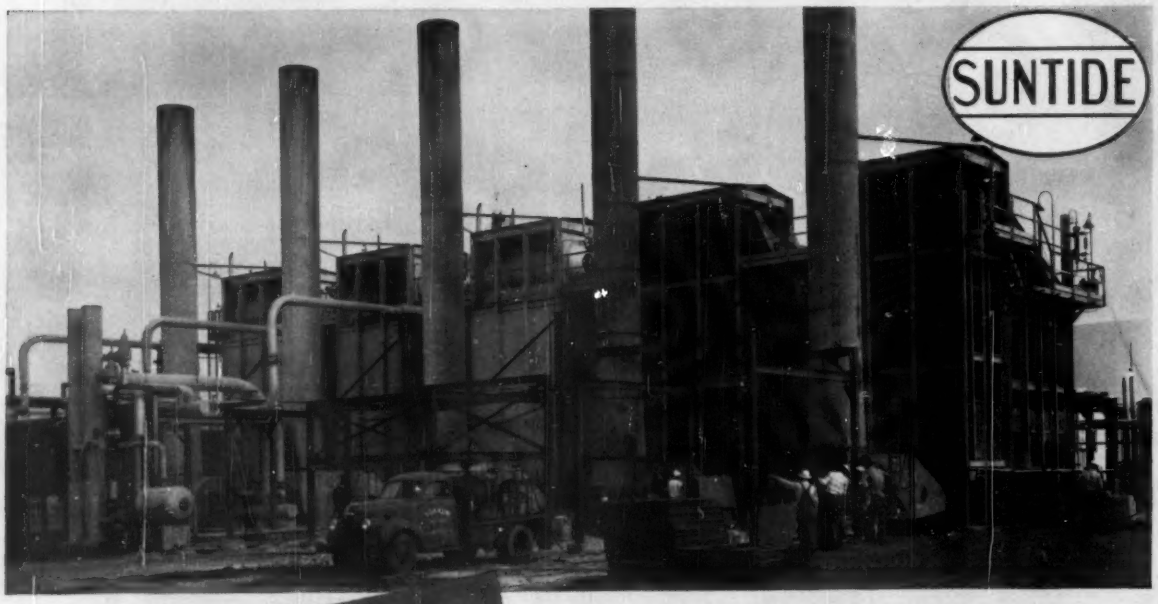
In this fast-moving age of missiles, we can't afford to let our thinking and problem solving lag. Here's how brainstorming can gear technical planning to high speed.

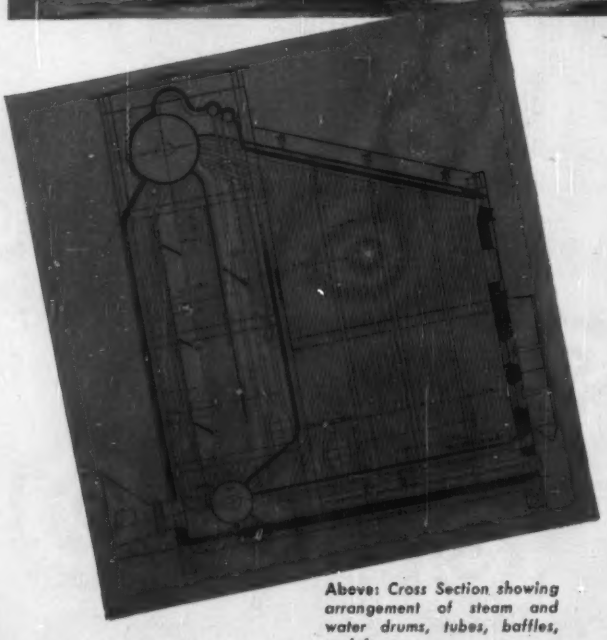
Next issue, we eye cost comparison methods

Properly and consistently used, any of the "exact" methods for making engineering cost comparisons and evaluations give equivalent results. Here's proof.

Vogt STEAM GENERATORS

at SUNTIDE REFINING COMPANY
Viola, Texas





Above: *Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.*

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- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
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Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

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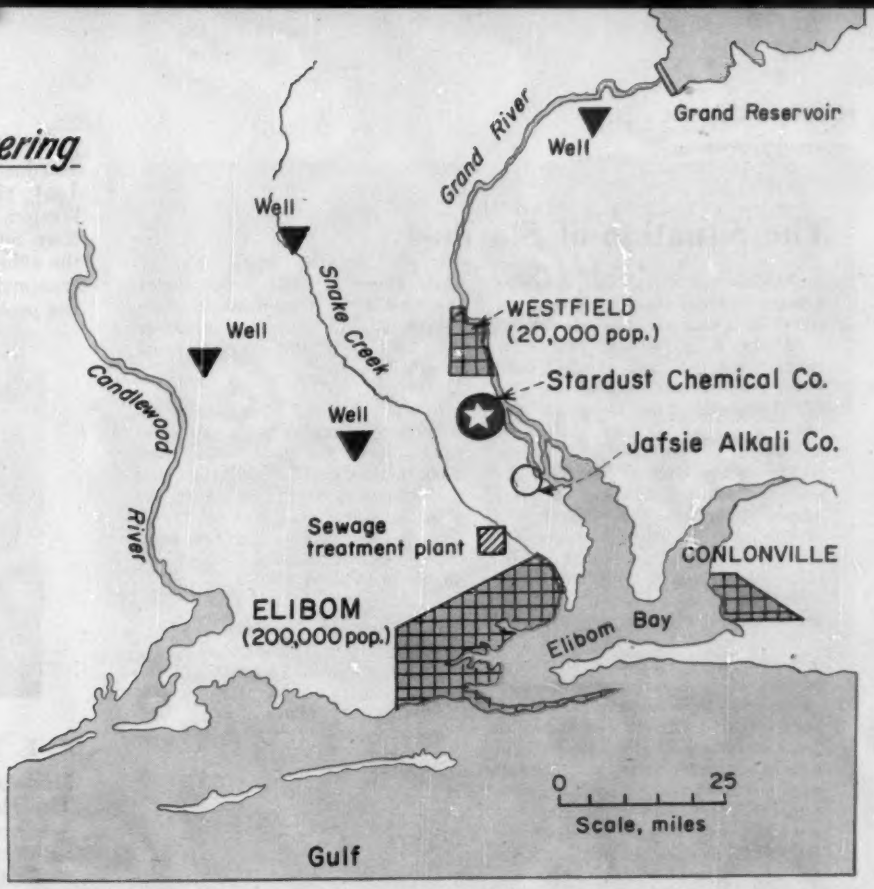
Chemical Engineering

JULY 14, 1958



How to Cope With a Pollution Problem

Hypothetical Stardust Chemical Co. is in trouble again, this time with public and fishermen over its contribution to water pollution in Elibom Bay. A panel of experts examines the problem, its implications, its possible solutions.

LAST December (*Chem. Eng.*, pp. 237-252, Dec. 1957) we met the imaginary Stardust Chemical Co. and saw how it solved a water-supply emergency demanding a 40% reduction in water requirements in 30 days. And now poor Stardust is again in difficulties. Expansion of its process facilities has greatly increased the quantity of effluent water discharged into adjacent Elibom Bay. The public is complaining, and rightfully so, because this effluent is killing fish, ruining the oyster beds and making the bay unsuitable for recreational use.

Stardust's progressive management is anxious to have good relations with the nearby town of Westfield as well as with the sportsmen and commercial interests using Elibom Bay. So it calls a public meeting of plant supervisors and technical personnel, municipal officials, state regulatory authorities and the public. The meeting considers the problem, its implications and the possible solutions. Stardust management then weighs the cost and agrees on the necessary corrective measures.

This sets the stage. The plant is hypothetical but the problem is real and is faced at one time or another and in one form or another by almost all process plants. Recognizing the universality of

The Situation at Stardust

Stardust Chemical Co. operates a petrochemical plant making a variety of synthetic organic chemicals, plus a 100,000-bpd. petroleum refinery, on the bank of the Grand River about 2 mi. south of the City of Westfield. The river at this point is a tidal estuary, the upper extension of Elibom Bay, somewhere on the Gulf of Mexico. The chemical plant discharges an average of 3,500 gpm. of effluent, and the refinery 15,000 gpm. into the river. Both city and plant secure their water supply from the Grand Reservoir and pollution of their water supplies is not a problem.

Westfield is without a municipal sewage treatment plant and population growth is making this necessary. Nearby Elibom gets its water from wells and disposes of its sewage in a treatment plant. Stardust uses septic tanks for sanitary sewage. Refinery and chemical plant have separate sewers for discharging final process effluents to the estuary. Composition of effluents, which is shown in the table, has become more complex and more difficult to treat as plant activities have diversified. Furthermore, the shuttling action of the tides in the estuary tends to minimize dilution, while there is little fresh water available from Grand River since Westfield and Stardust together take 60-75% of the overflow from Grand Reservoir.

Public demand for pollution abatement, coupled with the company's desire for good public relations, makes further pollution control steps necessary. Therefore, the plant technical staff has set tentative quality targets for the combined effluent stream. These are shown in the last table column.

Composition of Effluents

	Present Effluents		Effluent Goals
	Chem. Plt.	Refinery	
Flow rate, gpm.	3,500	15,000	....
Temperature, °F.	120	130	100
Oil content, ppm.	0	200–400	30
DO, ppm.	−20	−10	+5
COD, ppm.	4,000	300	100
BOD, ppm.	1,900	200	60
pH	5–9	2–11	6–8
Turbidity, ppm.	20–100	300–700	50
Susp. solids, ppm.	20–100	200–700	50
Sulfides, ppm.	2–3	20	1
Phenol, ppm.	0	10–30	4
Ammonia, ppm.	....	10	3
Phosphate, ppm.	0	0	0

the problem, the Industrial Section of the 40th Texas Water and Sewage Works Association's Short School put itself in this situation at Texas A & M College last March 6. We recorded the all-day session, and give you here the gist of our 137-page transcript.

The program for the meeting was arranged by T. L. Satterwhite of Humble Oil Co., Baytown, Texas. Meeting moderator was K. E. Mills, American Oil Co., Texas City, Texas, who took the part of Stardust's resident plant manager. S. O. Brady, of Humble Oil Co., Baytown, acting as the representative of the New York management of Stardust, summarized the panel's recommendations and decided on the measures to be taken, both short- and long-range.

Six panelists posed the problem and brought in recommended solutions. Cecil Reid, executive secretary of the Sportsmen's Clubs of Texas, dealt with the effect of pollution of Elibom Bay from the standpoint of recreational and commercial fishing and oystering. Joe D. Carroll, state Assistant Attorney General, described the policies of the state pollution regulatory bodies. Henry Wilkens, Jr., of the consulting firm of Freese, Nichols & Turner, took the part of a consultant for the City of Westfield in describing how the pollution problems of both the city and the plant might be settled jointly and to the advantage of each.

Discussion of the pollution sources in the plant, and the degree to which they are now being controlled, was in the hands of A. R. Pettyjohn, Union Carbide Chemicals Co., taking the part of Stardust's chemical plant technical director; and of R. P. Gulley, of Gulf Oil & Refining Co., acting as the Stardust refinery technical director. Last panel member was R. F. Weston, water consultant of Newtown Square, Pa., who showed how the effluent remaining after present treatment could be handled to abate the problem.

S. W. Water Works Journal

K. E. MILLS:
Moderator Introduces The Problem

LIKE the 1957 Panel meeting on "How to Cope with a Water Shortage" (see *Chem. Eng.*, Dec. 1957), this program is an experiment in workshop technique in which our panel takes a real but hypothetical problem, explores its implications and then comes forth with some practical solutions. The conditions of the problem (see box, this page) show that Stardust Chemical Co., a joint petrochemical and petroleum refining operation, is situated on a tidal estuary somewhere on the coast of Texas.

Stardust's growth and diversification have greatly added both to the load of effluent water discharged into the estuary, and to the complexity of its treatment. However, Stardust's management is highly sensitive to public opinion and anxious for public good will. It has called this meeting of representatives of the public and the plant to explore what needs to be done and how this can be accomplished.

Therefore, we shall hear comments from the recreational and commercial fishing and oystering interests, from the state regulatory bodies, from the local municipality, from the chemical plant and refinery, and from an outside expert on pollution control. After due consideration of the economics of the problem, our management in New

York will decide on the steps to be taken and will report back to us on what will be done.

Texas Fish & Game Commission

CECIL REID:

Wastes Have Damaged Fishing and Oystering

As THE representative of the Sportsmen's Clubs of Texas I'd like to explain how our organization handles problems such as those we now find in Elibom Bay. When a local outdoor club calls on the statewide organization for assistance we send in a subcommittee of our well-qualified 20-man technical committee. They study the problem and report as they have here.

A few years ago sports fishing was good in the waters below the plant. Sports fishermen and tourists alike caught good strings of bass, sunfish and others that move in and out from the sea. But, now that the stream has become polluted, fish are seldom caught. Furthermore, what was formerly a $50,000-a-year oyster industry has disappeared. Other types of animals which formerly used the water have all migrated, including the squirrels and the wild turkeys. Since the decline of fishing the tremendous tourist trade of the area during the winter months has largely ceased.

Let me explain what has happened. Harmful materials in the plant effluents reaching the stream have eliminated all the plankton, thus destroying the food chain. The few surviving fish are from spawn which occurred before the pollution arrived, and they cannot be expected to live much longer. Crustaceans which formerly served as fish food no longer exist. The same is true of both the minute plant life and the larger plants and the area has become a near biological desert which extends some 25 to 50 mi. from the mouth of the stream.

The disappearance of oystering represents an important commercial loss. The oyster is an animal which, after the spat is set, must remain in one place and take in what food particles pass through his digestive system as he opens and closes his shell. In this operation he both breathes and gathers nourishment. With the coming of harmful materials the oyster has given up the struggle for existence and now the survivors are too few for profitable working.

About the only way we can hope to revive this important industry is to re-establish the reefs which have become barren through pollution. The first step is to rid the plant effluents of harmful materials which may reach the bay. This will also restore the bay as a highly prized nursery ground for trout, redfish and some of the smaller fish.

These fish move into the area as soon as the spawn hatches. The trout actually spawn in the bay. The redfish spawns in the Gulf and comes to the river mouth to procure food. The shrimp moves in at

Who The Panel Members Are

K. E. MILLS (Moderator)—Technical Advisor, American Oil Co., all refineries. On receiving his BS, Chem. at the University of Illinois in 1940, Mr. Mills joined the American Oil Co. as an analyst and laboratory supervisor. From 1950-1957, he served as Technical Advisor of Waste Disposal at the Texas City refinery.

CECIL REID (Spokesman for Sportsmen)—Exec. Sec., Sportsmen's Clubs of Texas, Inc. A grad of Texas A&M, Mr. Reid, has chalked up an enviable record in wildlife conservation: a onetime associate professor in Wildlife Management at A&M; 7 yr. with the Texas Game and Fish Comm. as Chief Marine Biologist and Asst. Director of Fresh Water Fisheries.

JOE R. CARROLL (Spokesman for State)—Asst. to Texas Attorney General; Oil, Gas & Water Div. Mr. Carroll studied chemical engineering at Texas A&M from 1939 to '41, then went for a law degree—receiving his LLB in 1950. After leaving a 4-yr. office as Attorney for Anderson County, he took charge of the State's pollution abatement program.

HENRY WILKENS, JR. (Consultant)—Project Engineer, Freese, Nichols & Turner, Consulting Engineers, Houston, Tex. A graduate of Rice Institute where he received a BS in ME in 1929, Mr. Wilkens holds professional licenses in both Texas and Louisiana. Prior to his present position, he held office as District Manager of the Texas Water Co., Houston, Tex.

A. R. PETTYJOHN (Chemical Plant Technical Director)—Dept. Head, Union Carbide Chemicals Co., at Texas City, Texas, plant. Holding a 1936 BS, Chem. from the University of Illinois, Mr. Pettyjohn joined Union Carbide as a laboratory chemist. In 1942 he moved up to his present position with the Water Treating & Waste Dept.

RALPH P. GULLEY (Refinery Technical Director)—Staff Engineer, Gulf Oil Co., Port Arthur, Tex. In 1947, Mr. Gulley completed his studies at Louisiana State University, and was awarded his BS, ChE. On graduation, he started his professional career at Gulf's Port Arthur refinery. He has since worked with pollution control and water treatment groups.

ROY F. WESTON (Consultant)—Roy F. Weston, Inc., Newtown Square, Pa. Mr. Weston has spent more than 20 years in the fields of public health, water and wastes engineering. He holds both bachelor's and master's degrees in sanitary engineering. He has authored or coauthored more than 30 technical papers on pollution control and waste disposal.

SIDNEY O. BRADY (New York Management Spokesman)—Senior Research Chemical Engineer, Humble Oil & Refining Co. Employed by Humble for 21 yr., Mr. Brady's duties involve prevention of air and water pollution. A recipient of a 1937 Kansas State BS in ChE, he's a member of the Air Pollution Control Assoc. and Fed. Sewage & Ind. Wastes Assoc.

about the same time. In fact, it's now about time for the shrimp larva to come through the passes and move into the inland bay waters occupying the same grounds as the trout and redfish. But since the plankton is gone and other food which comes down the river is either dead or poisonous, the shrimping has now gone the way of the fishing.

We sportsmen, as well as the commercial fishermen, are much interested in re-establishing these fishery grounds and bringing the oysters and shrimp back to normal production again. You plant people have recognized that your effluents have caused this trouble and we are happy to learn that you propose to eliminate the causes of the trouble.

JOE R. CARROLL:

The State Must Act on Stream Pollution

BEING a one-time chemical engineering student turned to law, I naturally have an interest in the waste disposal problems of industry, as well as in the legal aspects of the problem. Let me tell you how the State gets into this matter, and what its attitude is likely to be.

Here in Texas water pollution is monitored primarily by the State Health Department. However, it is also a concern of the Game and Fish Commission in so far as it affects game and fish. The Railroad Commission is interested if the pollution comes from oil or gas wells, while the State Board of Water Engineers comes into the picture if fresh water supplies are endangered.

Although *I* can't speak for these organizations I think I can explain the philosophies that prevail in the enforcement of the pollution laws.

Why is the State concerned with stream pollution? Ordinarily we prefer to keep our government at the lowest effective level, which would mean ordinarily that the local county or district attorney would be charged with anti-pollution enforcement. This is effective for purely local pollution but pollution often occurs in one county, with damage resulting in another. Pollution in the upper reaches of a stream can cover many counties so the situation then calls for a general rather than a local treatment.

Now, you may ask, why not let the people who are damaged bring law suits? A man injured by an automobile will bring suit. The State doesn't sue the offender for him. But pollution brings different problems. For example, many occupations and recreations are affected to which very little pecuniary value may attach. How much is it worth to be able to swim in the Bay? Certainly, not enough to justify a $2,000-$3,000 lawsuit against the offending industry. Furthermore, the individuals affected often do not have the technical skill, knowledge or facilities for tracing and abating pollution.

So, what will the State do if pollution prevails? First, it will send in technical people to find what causes the pollution, what and who are responsible. Then the next step, most probably, will be for the attorney general to call in those responsible, apprise them of the trouble and encourage them to take care of it with all dispatch.

If the offender impresses the enforcement people as recognizing his responsibilities and being prepared to fulfill his obligations, if his program seems capable of coping with the situation and is actually carried out with success, then that is the end of the State's concern.

However, if the offender gives only lip service and the enforcement people feel he needs a little extra incentive, then a law suit seeking an injunction will probably be filed. If the injunction is granted the pollution must stop—which may mean shutting down the plant.

This is not a step to be taken lightly since it will throw people out of work and suspend production of products of much value. So a consideration of the consequences of a judgement will enter prominently into the thinking of those charged with enforcement, along with the question of how long the pollution has existed and how serious it is. Of course, there are some situations—for example, where a municipal water supply is endangered—where drastic action would have to be taken. But, in general, we must temper the abatement demand with good judgement, while seeing that the conditions are corrected.

Where several agencies are responsible for a given pollution the State is not required to prove the exact extent of the responsibility of each, but to show only that each contributes materially. In such a case, carried to the point of a suit, we would press for judgments against all the polluters.

Finally, I want to point out that we have no State agency that can approve or authorize any solution to a pollution problem. To do so in a case where the approved method did not prove successful would put the State in the position of having approved a polluted condition of a public stream.

This is logical for another reason. You industry people are closer to the problem, and closer to the solution. While the State has good engineers, industry has many more of them. Therefore, you are better able to analyze whether a given solution is workable. If not, you had better try something else.

HENRY WILKENS, JR.:

Treatment Tiein With Westfield Is Practical

AS CONSULTANTS to the City of Westfield, our firm has been exploring the City's sewage treatment problem and we have come up with a solution involving combined treatment of the Stardust

and city effluents which will be advantageous to both.

Westfield has no treatment facilities at this time. It discharges raw sewage into the Grand River not far above the Stardust plant. It has been growing rapidly and we are now figuring on a design population of 20,000. Pressure from the State Health Department, as well as the obvious need from an esthetic standpoint, has caused the City Council to decide to investigate and plan the needed facilities.

Westfield was originally served by wells but as it grew the city and Stardust jointly developed the present surface supply in the Grand Reservoir. About 1½ yr. ago growth forced the city to make water and sewer improvements which were financed by a revenue bond issue. This has committed the city's present revenues for the next several years. It is therefore unable to issue further revenue bonds for sewage treatment facilities.

This leaves only two alternatives: to finance with tax bonds—which would be politically unpopular—or to work out a joint arrangement with the Stardust Chemical Co. Here, Stardust would own the joint facilities and would receive the city's raw sewage effluent at a mutually agreeable point. The city would pay for treatment according to the strength and volume of the sewage delivered.

The first alternative, in addition to being unpopular, would not be entirely equitable in spreading the burden of costs among owners of both improved and unimproved land, alike.

The second alternative has mutual advantages. Stardust has a progressive management which is anxious for the good-will of the nearby city. Also, the city's domestic sewage load would be helpful in the treatment of the plant's industrial wastes. From the city's standpoint, its contribution to the total load would be a minor part. Therefore, its contribution to the fixed charges and operating costs would be relatively minor and would appear on the city's books as an operating expense. This would in no way endanger its bond position.

Furthermore, the incremental cost due to the city's contribution to the combined load would be considerably less than if the city had to carry the entire cost of operation of its own sewage treatment plant. So, the consulting engineers' recommendation to the city is to adopt this second alternative in cooperation with Stardust Chemical Co.

What about this added load from the city? At the design population of 20,000, Westfield's share of the combined load would be about 4,000 lb./day of BOD, based on 0.2 lb./day per capita—a little higher than the usual estimate figure of 0.17 lb. The volumetric load would be roughly 2,000,000 gpd., with the average 3-hr. peak at the rate of 3,000,000 gpd. Should the city construct the plant itself, it would come to about $25 per capita, or about $500,000. Operating costs would run to some $30/MM gal. treated.

Mills: Will you clarify that matter of incremental costs?

Wilkens: If the city had to build the plant itself it would cost about $500,000. But it wouldn't cost Stardust $500,000 more to add the city to its load. So, whatever it costs additionally in fixed and operating charges is what the city would have to pay.

Comment: I'm with the Water Pollution Control Division, State Health Department. Through Public Law 660, a Federal program administered by the State, cities can get government aid for building sewage plants.

Wilkens: That amounts to 30% and not more than $250,000, so that would be all the help the city could count on—another reason why we favor the joint proposition with Stardust.

Comment: The Stardust plant has 3,000 employees, or an average of 1,000 per shift, which looks to me like a 200 lb./day BOD load. Isn't this a case of the tail wagging the dog, when the city's load is 4,000 lb./day BOD?

Pettyjohn: The BOD load from Stardust is many times greater than its sanitary sewage load, coming mostly from its chemical wastes, so Mr. Wilkens' proposed plan would definitely not be a case of tail wagging.

Wilkens: I mentioned before the company's interest in good public relations. The city could go ahead and build its own plant, by issuing general obligation bonds. This would not only be unpopular with the citizens, but this unpopularity would tend to extend to Stardust. Thus, even though it would mean a somewhat larger initial investment for Stardust to build the combined treating installation, I'm sure Stardust would find it advantageous to negotiate with the city from the public relations standpoint alone, if for no other reason.

Mills: Now that we have heard from the public, the State and Westfield's consultant, Mr. Pettyjohn will tell us about the chemical plant's wastes and Mr. Gulley about the wastes produced by the refinery. Then our consultant, Mr. Weston, will show how our problems can be solved and what his plan will cost.

S. W. Water Works Journal

A. R. PETTYJOHN:

Variable Composition Is Plant Waste Problem

My report deals with the wastes and other sources of pollution, with the pollution load and its control, in Stardust's chemical plant. You will hear about the refinery separately. Stardust Chemical Co.'s chemical division manufactures synthetic aliphatic organic chemicals. Nearly all are at least slightly soluble. The plant is several years old and operates virtually independent of the refinery. It was laid out before the days when pollution was considered.

All units of the plant are situated on a single street, with water treating and steam generation at one end, the effluent treating facilities at the other, and the chemical units between. There is one gravity sewer down each side of the street to collect all wastes, both sanitary and industrial. Each building has its own septic tank which drains to the common sewer. As in most chemical plants, each process unit has a number of usually inaccessible connections to the underground sewer, making surveys difficult or impossible.

The effluent facilities themselves consist of two lift stations, one for each gravity sewer, which raise the water to ground level where it flows to a single badly overloaded clarifier. Following that the water flows through two settling basins. Floating material is no problem since we have little oil, so a split or slotted pipe skimmer on each settling basin adequately removes all floating material.

There are also two old sludge basins originally used for settling material from the plant waste water stream. Since we now have another use for these basins, to be mentioned later, we now pump the settled material to an off-plant disposal area on the estuary bank, where it is producing land fill.

We operate so far as possible on the principle that if we don't let organic material get into the waste water, then we won't have to take it out again. So, all organic liquids that can be kept out of the water, or separated from it, are accumulated for burning in a single open-air burner. There is also an incinerator for paper, trash, wood and other solid combustibles.

The general quality of the effluent is shown in Column 1 of the table (p. 136). No comment is needed except to point out that the 5-9 pH is actually the control range. Average pH is pushing 9 pretty hard. The turbidity flowing over the effluent weir rarely goes over 20 ppm. in dry weather, although it may increase to 100 ppm. or more during a rain. Note that sulfides are very low.

I want to emphasize the complex and rather unpredictable mixture of wastes that is likely to come from a chemical plant. Refinery processes are pretty well standardized but in making chemicals there are often many ways of making the same compound. Even two plants of the same company, making almost the same products, may use different processes due to local peculiarities of raw materials or operating limitations. And even in two units of different plants which use the same basic synthesis you'll probably find variations in operating conditions because they are attempting to suppress or enhance the formation of different byproducts.

Another complicating factor comes from the fact that different units of the plant will all be operating at different rates owing to demands of the sales department. So you have "normal" variations in the waste streams from individual units, to which you must add variations in the proportions of the streams from various units. The combinations are practically infinite and it's impossible to say that because we have a particular combination of wastes today, the composition will be thus and so tomorrow. The figures in the table therefore are only averages, with the maximums and minimums differing widely.

Add to all this the layout of the underground gravity sewer with its 30 major taps from processing units, plus connections for septic tank units. So far we have found no acceptable way of gaging or sampling so many buried lines.

Wastes arise from the water treatment unit, from boiler and cooling tower blow-down, from the sulfuric acid and gas plants, and from the various synthesis departments. The latter include the ethanol–acetaldehyde–acetic acid units, the oxide-glycol unit, the amine synthesis and chlorinated hydrocarbon plants, and the butadiene unit. Then, there are the wastes from auxiliary departments including the office, shops, tank farm, shipping, and so on.

Water treatment for boiler feed and drinking uses a typical cold lime-soda-copperas process, with sodium zeolite treatment of the boiler feed. The primary softener sludge has a valuable clarifying effect on the total plant effluent. Also, half of it is pumped to the gas department for clarifying a process stream before it is sewered. The small amount of boiler blow-down is useful in one of the gas plant scrubbers because of its alkalinity, non-scaling quality, and absence of dissolved oxygen (DO).

Nor does the cooling tower blow-down offer a problem. It is treated with 40 ppm. of chromate and 20 ppm. of phosphate. No chromate shows in the effluent since it is probably reduced to trivalent and precipitated as hydroxide or subhydroxide. Phosphate is also absent from the effluent because of its high calcium content which comes from limestone neutralization of waste HCl in the chlorinated hydrocarbon plant.

The sulfuric acid plant, of course, produces some acid waters from spills, breaks and foam-overs. The scrubber water contains some SO_3 and we may re-use it in the cooling tower if its degassification should prove feasible. We have a pit for the acid water where we accumulate spills, hold the water until we neutralize it and then discharge it to the sewer.

The gas department is the source of most oil waste as well as occasional high pH material and some sulfide scrubber water blow-down. This last is held in a surge tank and released at a steady rate to the sewer so the sulfide level in the total waste is not too bad. There is also a waste water stream which is largely emulsion. This, we find, can be broken by biological activity if the waste is lagooned along with some soluble organics for 2-5 days.

Among the chemical units the ethanol–acetaldehyde–acetic acid group contributes about one-third of the total plant organic load, all soluble. Aldehydes lost to the sewer add to immediate oxygen demand as well as to BOD. This waste is also acid and is neutralized with lime, but a pH of 4-5 is about the best limestone can do with acetic acid.

The oxide-glycol unit loses very little organic to the sewer. What is lost seems to have a very long BOD—20 to 60 days—so we hope that water will be out of the estuary before it can cause trouble. The amine unit also loses little organic but does contribute a high NaCl load which cannot economically be recovered. It is therefore washed to the sewer with a recycled effluent water from another process.

The chlorinated hydrocarbon plant is a low pH contributor owing to the production of byproduct HCl which cannot be economically reclaimed. It would play havoc in the sewer if not neutralized so it flows through a limestone neutralizing pit, thereby providing the high calcium content of the total effluent. For obvious reasons we have to keep the neutralized stream away from any waste with sulfate content.

We make butadiene by both the hydrocarbon and the ethanol synthesis methods. The first contributes small amounts of chlorinated hydrocarbons, some oil and traces of butadiene. Low pH, mainly acetic acid, comes from the second process. Although the copper content of this stream is some-

times pretty high, copper does not reach the final effluent, being precipitated evidently as carbonate or sub-carbonate.

At Stardust we lose very little of our product. Most organic going to the sewer consists of the small quantities of numerous byproducts that cannot be economically recovered. What we can, of course, we keep out of the waste water. Our non-sewered wastes consist of burnable liquids; tars and solids which sometimes can be dissolved in liquid burnables; waste waters highly contaminated with organics, with acids or alkalis; plus combustible and non-combustible trash.

Burning is the ideal disposal method when it can be used. Unfortunately, not all organic wastes can be burned. Some we bury when there is no problem of ground water contamination. Some, highly contaminated but too dilute to burn, we lagoon in the two old sludge pits. Over a period of time acclimated biological growth has been established which effectively handles organics of high odor factor. That part not destroyed biologically is bled back to the main effluent at a relatively constant rate.

Various highly acid or alkaline wastes resulting from wash-outs, cleaning and spills have to be handled individually. Some of the extreme pH's still contain very little actual acid or alkali and can be bled to the sewer. Others have to be neutralized on the spot.

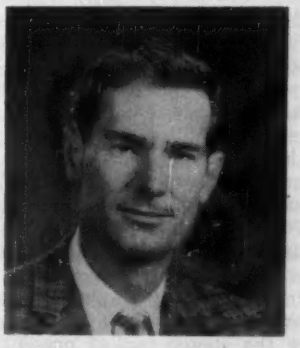
Among our in-plant waste control methods we've found an intensive education program to be most effective. Part of our effort is to sell the waste disposal group as an aid to the maufacturing departments, rather than as a disturbing influence. In controls, we've developed a system of ticketing each disposable organic waste. The ticket, filled out by a responsible member of the manufacturing unit, serves the safety angle nicely in warning of handling and mixing hazards. Since the information on the ticket is in the records, it also has the effect of decreasing the volume of waste. It also helps in our effort to charge each unit with the disposal costs of its own waste.

Sewered wastes are difficult to monitor as they leave the producing units. Once they've mixed with the total effluent they show up simply as more BOD or COD, very hard to trace to the originating unit. Sometimes we can spot a specific compound with only one source but one of the best tests is an organic chemist's sharp nose. Another thing we watch is water usage. If somebody uses more water than normally, invariably it's because he used it to wash a boo-boo down the sewer.

Our plant effluent records are extremely important to us. They show plant trends such as changes in operation. And sometimes they make nice evidence that we weren't the ones to kill those fish!

Our effluent testing is not in a particularly happy state since the BOD test seems to give both slow and inconsistent results. There is a crying need for a quick test which will give a number related to a true BOD. So far we've had little luck in this regard.

As for present status: we've just about reached the end of the possibilities for improvement in in-plant housekeeping. With a little further tightening up, and little expenditure, we can probably drop that BOD from 1,900 down to 1,000 or 1,200. To get beyond that point will take a major expenditure—for example, for biological oxidation. However, we feel that the disposal group has done considerable good since we've held effluent organic content and volume constant despite the doubling of plant output in recent years.



R. P. GULLEY:

Refinery Can Meet Goal With New Investment

OUR REFINERY'S pollution problem can be worked out by in-plant treatment methods at an expenditure of roughly $2,000,000. Our research department has come up with workable methods, most of which have worked elsewhere in practice.

Stardust's refinery is a typical 100,000 bpd. installation, running mainly on high-sulfur crudes. Its main units include two new 30,000 bpd. and two old 20,000 bpd. atmospheric-vacuum crude oil distillation units; two fluid cat crackers; reforming units; vis-breakers; a sulfuric acid alkylation unit; and other facilities including an old 100 tpd. sulfuric acid plant, a refinery gas handling unit, product and lube oil treatment facilities, and utilities.

We use about 100,000 gpm. of cooling tower recirculation, plus 10,000 gpm. of once-through cooling water from the Grand River. This latter varies from brackish to fresh. Our fresh water load is about 8,500 gpm. which is clarified and filtered. About 1,400 gpm. is softened for the boilers, 5,200 gpm. supplies cooling tower makeup, and the remainder is for general refinery use. A segregated line handles sludge and backwash from the water treatment, along with boiler blow-down. 15,000 gpm. of other effluent waters (including the 10,000 gpm. of once-through water) flows through the refinery separator to the Grand River. During rainstorms this may go to 17- to 18,000 gpm.

Although the plant is old it has been considerably modernized. Its common sewer system handles process water, storm water and most wastes. This sewer terminates in an overloaded and outmoded refinery separator so our waste water handling is in poor shape. Storm water goes through this separator also, resulting in high peak loads. There are no sanitary treating facilities.

In the table on page 136 we have listed the present refinery effluent composition, the goals, and a series of five steps through which the goals can be reached. The table shows what investment will be needed for each step.

One of the first things we note from the table is that the 30 ppm. goal for oil can't be reached with our present outmoded separator—or even with any conventional separator. So we believe that effluent clarification will be needed. This need is strengthened by the high suspended solids and turbidity levels which must be dropped to 50 ppm. or lower.

It becomes obvious that eliminat-

How Effluents Analyze and How Refinery Goals Can Be Reached

	Present Effl. Composition		Effluent	Contemplated Improvements*				
	Chem. Plt.	Refinery	Goals	Step 1	Step 2	Step 3	Step 4	Step 5
Temperature, °F.	120	130	100	95	95	95	95	95
Oil content, ppm.	0	200–400	30	500	20–30	20–30	20–30	20–30
DO, ppm.	−20	−10	+5	0	+5	+5	+5	+5
COD, ppm.	4,000	300	100	560	316	142	119	93
BOD, ppm.	1,900	200	60	370	210	95	66	62
pH	5–9	2–11	6–8	6–8	6–8	6–8	6–8	6–8
Turbidity, ppm.	20–100	300–700	50	150–250	20–30	20–30	20–30	20–30
Suspended solids, ppm.	20–100	200–700	50	100–200	10–20	10–20	10–20	10–20
Sulfides, ppm.	2–3	20	1	62	62	>1	>1	>1
Phenol, ppm.	0	10–30	4	30–90	30–90	9	3.5	>1
Ammonia, ppm.	....	10	3	30	30	30	2	2
Phosphates, ppm.	....	....	....	....	....	....	....	....
Cost of steps, $1,000	....	....	....	1,206	700	93	4	4.5

*Step 1—New acid plant, plus elimination of once-through water by installation of cooling towers, etc.
Step 2—Effluent clarification.
Step 3—Sulfide strippers on spent caustic and sour waters.
Step 4—Phenol consumption in cooling towers.
Step 5—Recovery of naphthenic acids from spent caustics.

ing the 10,000 gpm. of once-through water would be a big step toward making effluent clarification feasible. Preliminary investigation shows that it would cost about $50/gpm. to get rid of the once-through water with cooling towers and associated equipment, but would cost about twice that for equipment to clarify that additional amount of effluent. Without the once-through water, our separator would perform better both because of the lesser loading and also through elimination of the solids which would precipitate from the estuary water. These solids would form emulsions and cause oil carryover. Finally, the once-through water—three-quarters of the present effluent flow—carries a great deal of heat to the effluent. Its elimination would enable us to meet the temperature goal.

To get rid of the once-through water we would have to enlarge the present cooling towers serving the barometric condensers on the older atmospheric-vacuum topping units, substituting surface condensers. This would come to $340,000. The present cooling tower serving the new section of the gas plant could be enlarged for $45,000 to handle the coolers for the older section. Substitution of air coolers for the present once-through water boxes for vacuum-tower bottoms cooling would add another $107,000, bringing the total for once-through water elimination to $492,000. This completes the first part of Step 1.

Our effluent water is generally acid, except for times when a batch of spent caustic is dumped. This comes from the old acid plant which utilizes outmoded methods for handling spent acids and sludges. Of this plant's 100 tpd. of acid output, about 25 tons ends up in the sewer in the hydrolysis step, about 25 tons is burned under the boilers as acid oils, and about 50 tons is actually recovered. Neutralization would precipitate a lot of calcium sulfate and cause a solids problem in the separator. We could sell our spent acid to Jafsie Alkali Co. a few miles down the estuary, but this would add $400,000 a year in acid costs. A new acid plant for $700,000, plus some $14,000 for added pH control facilities at the separator, seems our best solution. This would bring the total for Step 1 to $1,206,000.

Effluent clarification, Step 2, would cost around $700,000. Two clarifiers with a total capacity of 6,000 gpm., would handle the remaining 4,800 gpm. of normal effluent, plus storm water peaks, after elimination of the once-through water. This would involve lagooning the sludge but at present we have a fair amount of area for this purpose.

Sulfides constitute the major source of BOD and COD in our wastes. Some 3,250 lb./day of sulfides come from the cat crackers and the desalter, and 690 lb. from the spent caustic. Using waste steam to strip the combined sour water from the FCC units and the desalter would release H_2S which would be flared. This installation would cost $76,000. Acidifying our spent caustic to pH 4-5 and stripping with open steam and fuel gas would release this H_2S for flaring. The acid oils would be skimmed and burned in the boiler house. This would add another $17,000.

These improvements, coming to $93,000 for Step 3, would bring our remaining sulfides down to the desired maximum of about 1 ppm. and would also eliminate 1,500 lb./day of phenols, 10,060 lb./day of COD and 7,070 lb./day of BOD. However, there is a possibility of selling our spent caustic which would require only $8,500 for segregation equipment compared to $17,000 for caustic stripping.

In Step 4 we propose reduction in the phenol waste streams. Some 300 lb./day leaves from the cat cracker sour water stripper, and 222 lb. from the spent caustic stripper. We propose to inject the first of these streams into the two cooling towers serving the cat crackers. These should give nearly complete bio-oxidation of the phenol. The remaining phenol, about 230 lb./day, would just about equal our 4 ppm. goal so the spent caustic stripper effluent could be sewered, provided it was held in a surge bank to allow smooth discharge. This step would cost only $4,000 and would eliminate some 180 lb./day of sulfide, together with 1,200 lb./day of COD and 800 lb./day of BOD.

All our goals except for COD and BOD can be reached with the first four steps. There is one segregated

stream, the spent caustic from prewashing furnace oil prior to sweetening, which contains some $80/day of naphthenic acid, now going to the sewer. Its recovery, for an estimated $4,500 investment, would reduce COD by 1,500 lb./day and BOD by 1,000 lb./day, and would also pay out in 100 days. This Step 5 would reach the COD-BOD goals.

Eventually we may require a precoat filter for emulsion handling, but the contemplated changes in our effluent will make the emulsion problem difficult to anticipate. There is also another point for the future. While we are eliminating sulfides from the water effluent, we are adding 50 tpd. of sulfur to the air by flaring H_2S. There are occasional complaints. Since we are concentrating this H_2S with amine units, the 100 tpd. of SO_2 could be converted to sulfur in a recovery plant costing $700,000 to $800,000, with a 3½-yr. payout after taxes. This is a worthwhile consideration for the future.

ROY F. WESTON:

Bio-Oxidation Is Main Answer to Problem

I WOULD FIRST like to comment on some of the problem's objectives. I feel that the temperature goal is perfectly in order and is attainable. The pH objective falls within the range of 6-8. I feel quite strongly that you are unnecessarily limiting yourself in this regard. A pH range of 5-9 should be most acceptable. It is entirely possible that we'll end up using some type of biological treatment to control this pollution problem. If such is the case, an influent pH range greater than 5-9 will probably give an effluent pH within the specified 6-8 range.

Oil concentration in the combined effluent has been set at 30 ppm. This value is close to the maximum that can be tolerated without evidence of irridescence or scum accumulation. On the other hand, it is very close to the absolute minimum obtainable in the presence of light hydrocarbons. Therefore, the objective appears to be a practical and obtainable value.

The objectives call for 5 ppm. of dissolved oxygen in the effluent. I feel that such a low value is desirable and can be attained, but is really unnecessary.

Also stipulated is a maximum of 1 ppm. of sulfides. It would be unusual to have dissolved oxygen and sulfides in the effluent at the same time.

Effluent specifications limit phenol concentrations to a maximum of 4 ppm. The median tolerance limit toxicity of phenol to sensitive forms of fresh-water fish is about 19 ppm. Although definite data as to the toxicity of phenol in brackish water are not available, in this case, it is probable that the 4-ppm. value would be biologically safe.

The ultimate goal for BOD concentration is 60 ppm. At this time, there is no definite proof that the concentration need be that low. On the other hand, there is no positive evidence that 60 ppm. BOD is low enough. The only justification for the value is that it is practical and can be attained by known effluent-treatment methods. It's my hunch that the river and bay can be adequately protected with higher BOD concentrations.

Finally, the objectives permit 3 ppm. of ammonia. If this is to occur as free ammonia, it will be approximately the safe toxicity threshhold for sensitive fresh-water fish. Therefore, we believe it to be a safe level for the brackish water.

I have been asked to consider the various alternatives for effluent treatment. These include:

1. Chemical flocculation, with
   (a) Sedimentation or
   (b) Flotation
2. Biological treatment, including
   (a) Trickling filters, or
   (b) Activated sludge, or
   (c) Stabilization basins.

Obviously, our objective is to determine the most economical solution to the problem. The various types of effluent treatment are competitive with in-plant work. Treatment evaluations are often made on the basis of experience and judgment. However, in this type of work, the multiplicity of variables and lack of quantitative treatment data make it highly desirable to conduct research and development investigations. We have done so.

Laboratory studies of chemical coagulation confirm petroleum industry experience. Approximately 95% of the oil and 70% of the BOD is removed by chemical flocculation. The data indicate that about 24 tpd. of sludge will be produced during treatment. Of this amount, 5 tpd. will be oil and about 5 tpd. will be dry solids.

However, in checking the chemical wastes, we found no significant BOD removal. Therefore, practical application of chemical flocculation is limited to the refinery wastes. In this case, floc can be effectively removed by either sedimentation or flotation.

Laboratory studies using batch biological treatment also supplied us with adequate information for the preliminary design of activated sludge and stabilization basin facilities. Continuous operating results were predicted from batch data using treatment-rate equilibrium data and mixing theory.

So far, we've conducted enough investigation to establish the fact that the waste streams are treatable. Although Mr. Pettyjohn has indicated that there is wide variation in the type of chemical-plant waste matter that goes to the treatment plant, we find that the stream will fit some general treatability pattern. We must, however, establish actual values if design is to be effective and economical.

There are some general aspects of effluent treatment here that we ought to consider now. Since chemical flocculation is limited to refinery wastes only, we are faced with the necessity of providing biological treatment. I know of no other more economical way of removing diluted organic matter from water than by biological treatment. It's possible that when we find out how much biological treatment is going to cost, we may have incentive to go back and reduce the organic matter losses at some of the units in the chemical plant.

With biological treatment, if we want to apply it to the combined effluents, we do have some problems, however. The combined effluents

from the two plants would have close to 300 ppm. of oil. The customary maximum figure for oil going to a trickling filter is about 100 ppm.

As far as activated sludge is concerned, oil is murderous. If the oil-to-BOD ratio exceeds about 0.1 to 0.2, you may expect to have enough accumulation of oil on the activated sludge floc to cause trouble with separation by sedimentation. For that particular reason, flotation has been used experimentally to remove activated sludge from the mixed liquor with some degree of success.

Therefore, it would appear that we have a borderline case. If activated sludge is to be considered for this installation, we must conduct pilot-plant investigations to prove its feasibility.

Now, I mentioned the matter of sulfides. It has been proposed by Mr. Gulley that facilities be provided to remove sulfides to about the 1-ppm. level. And, in general, I would certainly concur in that particular approach to this problem. However, I'd concur for this reason. In the case of trickling filters, sulfide concentrations of the ordinary magnitude of 10-15 ppm. will show a definite adverse effect on treatment efficiencies. In the case of activated sludge, the concentration can be higher, but sulfides can still cause adverse effects. As far as the stabilization basin system is concerned, we have no definite information as to just how bad or how good sulfides may be.

So, I'm going to make a recommendation that we defer the installation of complete sulfide removal facilities at this time. In the case that management decides on the treatment of the combined wastes in stabilization basins, pilot-plant studies should be conducted to establish the validity of our preliminary design basis.

Let's take up another problem for a minute—that of the storm water coming from both the chemical plant and refinery. Now, in the case of the chemical plant, since the storm water can be diverted for a sufficiently low cost figure, I am sure that that would be the better course of action. In the case of the refinery, we have to provide at least an oil separator for storm water. So we are probably going to have to consider provisions for hydraulic capacity in our treatment facilities.

At the present time, we are discharging approximately 60,000 lb./day of BOD into the Grand River. In order to meet the requirements that we have set up as objectives, the combined waste streams will require approximately 90% treatment. That is attainable without creating significant hardship.

To summarize, it would appear that the work that must be done is to (1) improve and expand existing separators; (2) provide pH control; (3) divert storm water from the chemical plant; (4) conduct the necessary in-plant work in the refinery to improve the effluent, especially those measures which show an economic pay-out; and (5) provide facilities for BOD and oil removal.

The alternates that we have for BOD and oil removal are a combination of chemical flocculation of refinery waste with biological treatment of the chemical plant waste, or biological treatment of combined wastes.

We've mentioned trickling filters, activated sludge processes and stabilization basins. In the case of the trickling filter or the activated sludge process, it is going to be necessary for us to use nutrients; in the case of the basins, this probably will not be necessary.

When I speak of stabilization basins, I do not mean just a hole in the ground—I actually mean an engineered impounding basin where sufficient air can be supplied to maintain aerobic conditions at all times. Also, complete mixing is essential. The basins are designed and constructed for enough operating flexibility to permit one to be removed from service without interfering with the general over-all efficiency of the treatment system.

I have made approximations of what it may cost to provide effluent treatment to meet the established goals under different conditions. As Mr. Gulley pointed out, chemical flocculation of the refinery waste would cost about $700,000. He is going to be producing a lot of sludge, for which he has a temporary disposal system of pits. If he were to provide complete sludge disposal facilities at this time, he'd have to increase that figure by about another $375,000.

If we are to provide treatment for the chemical plant only, using trickling filters, it could cost us about $2,000,000. If we were to provide activated sludge treatment, using the contact-stabilization process, it would cost about $1,750,000. And, stabilization basins would cost about $900,000. The principal difference between the cost of stabilization basins vs. activated sludge is in the cost of the structures. The aeration system is practically the same. In the case of the basins, we accumulate a well-oxidized sludge. It accumulates on the bottom of the basins, and therefore it can be disposed of intermittently at minimum cost. About four or five days of storage would be required, occupying possibly 25 acres of land.

If we combine the refinery and chemical plant effluents, a trickling filter system would cost about $2,300,000, the activated sludge process would go up to about $2,000,000 and the stabilization basin would be about $1,100,000. If the refinery waste is mixed with the chemical plant waste, it is also necessary to provide scum-removal facilities in the first of the series of basins. Also, it will be necessary to make arrangements to transfer this material to final disposal facilities.

We've discussed the possibility earlier of the company cooperating with the City of Westfield. It would be most advantageous for the company and the city, I feel, for that to occur. If we went to trickling filters, the investment would run about $2,500,000. If we used activated sludge, it would be about $2,100,000; the stabilization basin system would cost about $1,300,000. In this case also, we'd have to worry about the accumulation, skimming and disposal of floating material.

It seems to me that if the City of Westfield would provide comminution facilities on its own property, and would pump the city waste to the treating facilities, or let it flow by gravity, whichever might be possible, this would be a good deal for them. The nutrients and the seed that would be provided by the sewage should also improve treatment at the plant. It is obvious from the cost analysis that the most economical solution is that of using stabilization basins for the three combined flows.

In reference to the type of contract that may be negotiated between Westfield and Stardust, it would seem to me that the advantage to the municipality is sufficiently great, economically, that it could afford to pay prorated capital

investment and operating costs in accordance with the relative BOD and suspended solids loadings. The incremental cost would be very nice as far as Westfield is concerned, but in view of the fact that there are going to be extra operating problems and greater costs due to the addition of sewage, it would appear that the equitable arrangement would be prorated costs. These amount to somewhere around 7% of the total cost of the installation.

Moderator Sums up Problem and Solutions

MR. REID has told us of the destruction of plankton, fish, oysters and marine plants in the estuary and Elibom Bay. It is obvious that we shall have to take steps to clean up our effluents. Mr. Carroll, speaking from the viewpoint of the State enforcement authorities, has shown how the anti-pollution laws operate and how they are enforced. Mr. Wilkens, giving us the viewpoint of the City of Westfield in regard to its own sanitary sewage problem, has developed a plan of joint treatment of Westfield's and Stardust's wastes which he has shown will assist the Stardust disposal problem while it saves the city considerable money and enhances Stardust's public relations.

Details of the waste disposal problems of Stardust's Chemical Division were given by Mr. Pettyjohn. We saw his difficulties with numerous buried outlets, difficulties in sampling, and an effluent which could vary widely from time to time. Our best in-plant method so far, he finds, is a general education program, coupled with a system of wastes ticketing which ties the waste down to the department producing it. However, he finds that in-plant controls have gone about as far as they can go and a major expenditure will be needed for the future.

Similarly, Mr. Gulley described the Petroleum Refinery Division's waste effluents and their sources. Everything possible to improve the effluent has been done and now, to achieve the goals we have set, we will have to make some rather sizable expenditures. He has developed a five-step program, each step of which would ease some part of the pollution load, while the combination of all would reach our over-all goal.

Finally we have heard from Mr. Weston, our consultant, who has examined our proposals and has come up with some of his own. He felt that our criterion of 6-8 pH was probably a little stricter than necessary and that a range of 5 to 9 would do. He found our oil goal to be borderline, as is our BOD criterion of 60. He felt our aims of 4 ppm. for phenols and 3 ppm. for ammonia were all right.

Mr. Weston's principal contention was that the main solution to our problems with oxidizable wastes would be biological treatment of the total effluent. Proper choice of the system would require lab and pilot plant investigations which, unfortunately from our standpoint, take time. However, perhaps this could be a crash program.

Question: Mr. Weston, you used the word "stabilization basin." Is that synonymous with "lagoon"?

Weston: Yes, but be careful how you use "lagoons" for "stabilization." Lagoons are taboo in the Northeast.

Comment: I wonder if we can't sharpen our pencils a little, at least on the waste stabilization part of the program. Our consultant points out that the dissolved oxygen is unnecessary and perhaps we needn't limit the sulfides. So perhaps he would consider an aerobic-anaerobic oxidation pond which would be aerobic during daytime, and anaerobic at night, just about doubling its capacity.

Weston: I expected someone to throw that one at me. There are two reasons why the lagoon system I mentioned should be completely aerobic. One is because it gives us a higher BOD removal rate. The other is avoidance of an odor nuisance. The system I have advocated is very simple and easy to construct—it's primarily a bull-dozing and a pipe-fitting job. It can be gotten into operation in a hurry. Of course, if your management is willing to go into an extensive research investigation we may be able to work out a better scheme. But at the moment I believe the proposed lagoon system is the most economical method that has been suggested here today.

Herman (Humble Oil Co.): What is the oxygenator in your waste stabilization pond—algae or mechanical means?

Weston: In this particular plant we would provide oxygen mechanically—through compressed air or some other aerating device. There are a number of installations where oxygen is being provided by riffle aerators, spray towers or similar devices. I know of no fullscale installations now using compressed air or mechanical aerating devices, but there is a plant on the boards which will probably use mechanical aeration. For such a system to be fully effective you must have complete mixing and you must have dissolved oxygen. Incidently, there's no indication of an erosion problem in the pond so long as the slope is not too horizontal.

Buster (Crown Central): Do you intend for us to retain the sour water strippers in the refinery?

Weston: I recommend that you defer any expenditures for reducing sulfide concentration of the effluent until we have a chance to see whether it will have an adverse effect on the stabilization lagoon. You may have no difficulty with sulfides in such a system because you are providing such a long-term aeration contact period. You were planning to spend approximately $93,000 for a sulfide stripper, and another $4,000 to divert a phenol stream to a cooling tower. I think both expenditures should be deferred until we see how the system works.

Buster: Perhaps if we stripped the sulfides out we'd have such a small oxygen demand that we could use an oxidation pond with algae and not have to aerate the whole 25 acres.

Weston: Well, we have an incoming BOD of about 575 ppm. and this would require a very substantial oxygen utilization rate. In the first basin, under aerobic conditions, the oxygen utilization may peak as high as 20-30 ppm./hr. I doubt you can do anything like that with algae.

Turn Page for Management's Conclusions

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S. O. BRADY:

Stardust Management Has Decided Its Course

SINCE your meeting, gentlemen, we have been considering the problems and the solutions brought out in your discussions at the Stardust plant and we have now come to certain conclusions.

Our board of directors believes that a good-neighbor policy is not only a real but a valuable asset. It is so serious about this matter that we have its approval of the projects we recommend—to the tune of from $2 million to $3 million.

The goals we have set, with one or two exceptions noted by Mr. Weston, seem realistic. However, I want to point out that these goals should be maximum goals, not average. By that I mean that we should not average 30 ppm. of oil over a month's time but should at all times be below 30 ppm.

Our immediate objective is to improve the quality of our effluent to such an extent that we will no longer be under pressure from any group, whether it be regulatory, citizens or sportsmen. And we must accomplish this with all reasonable speed.

We have therefore decided to accept the following recommendations. For the immediate short-range program:

1. We will accept Mr. Weston's proposal for biologial treatment of the total effluent by means of stabilization basins. Although we should go ahead with all reasonable speed, we feel it is only wise to spend whatever time is necessary for Mr. Weston to do the research and pilot work needed to give us a firm proposal. In that respect, this acceptance is tentative. We feel there is a possibility that he may wish to change his recommendations after completing his research, but until then we'll proceed on the basis of his present proposal. We shall certainly have to go in that direction since we know of no other way of treating our chemical plant wastes.

Furthermore, the low incremental cost of adding the refinery effluent makes complete treatment desirable.

2. Mr. Mills should immediately get to work with the Westfield city commissioners to complete arrangements for Stardust to treat the sewage from Westfield. Here we feel we should lean over backwards to demonstrate the sincerity of our desire to be good neighbors. However, we recognize that an equitable prorated cost basis should be established under which Westfield will pay for this treatment.

3. I'd like to consider Mr. Gulley's proposed steps in a somewhat different order and take up Step 5 first. We feel that the installation of a naphthenic acid recovery unit could have been handled by a local appropriation and probably should have been. It should be installed as soon as possible.

4. Considering Mr. Gulley's Step 1, the elimination of once-through water and the provision of a new acid plant, both are approved. The elimination of the once-through water is certainly imperative and we have no choice in the matter. The two-year payout for the proposed acid plant is a good investment and we want to make it, even with capital as tight as it is today. Coupled with the attractive payout, the new acid plant will have some worthwhile credits for pollution abatement so we shall proceed with the construction immediately.

This completes the short-range portion of our program.

Now, at Mr. Weston's suggestion, we'll defer Mr. Gulley's Step 3, the sulfide stripper since, with the combined effluents of the chemical plant and the refinery, we have only about 30 ppm. of sulfides. It is very questionable whether 30 ppm. of sulfides will have a detrimental effect on the biological treatment so we should defer this $93,000 investment for whatever time is takes to find whether it will in fact be necessary.

Step 2, the clarification of effluent, will obviously not be a needed part of the project, since it's taken care of by the biological treatment of the total effluent of both plants. Nor will Step 4 be necessary since the phenols can continue to be sewered and will be consumed by the biological oxidation.

Because the problem is quite urgent we are forced to adopt the entire program on a short-range basis. Normally, we would try to spread this expenditure over a two or three year period, but I do not feel we can afford to do so here. So our long-range program also will be pretty well taken care of, with the following exceptions.

Undoubtedly, we shall have new problems come up from time to time. They always do—problems that can not be foreseen at present. We'll have to keep on our toes and plan to work out remedies for these difficulties as soon as they occur so that the plant won't get into bad shape again in the future.

Also, I think there may be some element of doubt whether the goals we have set will actually produce the desired results in the bay. Surveys of its waters should continue and if it then appears that we have not alleviated the undesirable conditions, we may have some additional expenditures to make.

Then, there is the potential air pollution problem which Mr. Gulley called to our attention. He showed us that we are now burning H_2S equivalent to some 50 tpd. of sulfur and discharging it into the atmosphere. Although we haven't yet run into serious complaints about our SO_2 effluent, if we are sincere about being good neighbors we should start an immediate research program to determine whether a sulfur recovery plant or some other means will be the best for dealing with this problem in the future.

Henceforth, our policy at Stardust will be that each new unit added must take care of its own wastes. If the existing facilities are adequate to handle the new wastes, then the cost of treatment must be allocated to the process involved. This policy will provide for most of our future requirements.

Once we have solved the once-through water problem by the installation of new cooling towers and air coolers, then we shall have to take a careful look at our present refinery separators. With the new reduced flow these may be adequate. If not, we may have to modernize our separators. But, with that, we believe that the problems we can now anticipate will have been taken care of.

Consider Buying Used Equipment

When it comes to price and delivery time, It's hard to beat the large used equipment market. You have to be careful but second-hand equipment might fill your needs.

ROBERT R. IMSANDE, Chemical Engineer, Pittsfield, Mass.*

When the time comes around, and you're interested in purchasing an item of processing equipment—where do you start?

Most probably you'll call the nearest sales representatives of manufacturers that make the item you're interested in; take a look at what they have to offer. Or maybe, you'll write up a specification sheet and mail it to as many potential suppliers as you feel necessary.

Now, how many times have you thought of the second-hand market? Always? Occasionally? Never? If you're not a regular shopper in this market, maybe you should take a good, long, hard look at it. And if you are, there are a lot of pitfalls you should be aware of.

Here's the why and how of this large potential equipment source. You'll be surprised how well second-hand equipment might fill your needs.

The Price is Right

Used processing equipment costs a great deal less than new equipment. How much less depends on several factors.

Condition is one of the most important. Obviously, the better condition it's in the more you'll pay for it. We'll have more to say about condition later.

A second factor that regulates price is supply and demand. This "law" works more effectively in the used equipment field than with new equipment. We can see several reasons for this:

- More effective control by a second-hand dealer over costs than a new equipment manufacturer.
- Real stock in trade of a used equipment vendor is money, not a static inventory of items.
- "Buy it, sell it quickly and use the money to buy more" is the strategy of the successful used equipment dealer.

Whenever you consider equipment, naturally the price of the item is always important. There are some cases we run into where the importance of price is greatly accentuated. Pilot plant work is the perfect example. In pilot planting, you look at the factors—useful life and suitability—from a different standpoint than in commercial plants.

When designing for production purposes, normal planning is for a 10- or 20-year life, if not longer. Operation, generally, is continuous. Pilot plants are seldom designed for continuous operation over long periods of years. Here, used equipment, even with 50 or 75% of its useful life gone, may be significantly better than new equipment.

Equipment suitability—will it work—is often the bugaboo in pilot plant design. Many times it's the chief reason for pilot operations. Here, used equipment can hold costs down. Changes in process or product that require installation of another type of unit with subsequent discarding of the original can be pretty expensive. If you've installed second-hand units, the bite's a lot less.

New equipment manufacturers recognize these facts. That's why they operate test laboratories where potential customers can try their processes or product before purchase.

Delivery Time Is Short

Second important reason for buying used equipment is delivery. While we've—at least for the present—left the era of shortages and extended delivery periods due to large backlogs, new processing equipment still requires a fair amount of time between order placement and receipt.

Robert R. Imsande is a graduate chemical engineer from M.I.T. He has had extensive engineering experience in the chemical industry and is currently employed by G.E. as a project engineer.

This is seldom the case with used equipment. There are many instances where complicated items have been located in the second-hand mart, bought, delivered and installed in days rather than the weeks or months required if new units were purchased.

Dealers Are the Largest Source

Dealers represent the prime source of used equipment. They continually scour the field, buying anything from single items to entire plants. Their purchases are either returned to their base of operations for storage before selling or left in place for weeks or months for resale and shipment direct to the eventual purchaser.

As in any business, dealers come in assorted types and sizes. As far as type goes, there are two kinds—general and specialized. You can figure from the name that a general dealer in the chemical equipment field handles any type of item. Their lists include such diverse items as filters, dryers, tanks, pumps, mixers, towers and screens.

In contrast to general dealers, specialized ones limit themselves to single classes of equipment. Examples are: plastics machinery, valves, electrical equipment and steam boilers.

Estimated financial strengths are listed by Dun and Bradstreet. Here, a sampling of used-equipment dealers show financial strengths from under $3,000 to in excess of $300,000.

For a wider selection, the larger dealers usually have the most to offer. Unfortunately, the problem generally becomes one of finding an item that best fits your requirements. So don't overlook the smaller dealers. The unit you want may be in their hands.

Finding the dealers represents no problem. *Chemical Engineering's* "Equipment Searchlight" normally contains the advertisements of some twenty dealers, listing a sample of their stock. Other business publications include similar classified columns.

Most dealers also use direct mail selling: distributing periodic flyers to past or potential customers.

Companies Sell Equipment

A second source is the unneeded equipment sold by concerns not in the used-equipment business. Some companies prefer to dispose of these items on the open market rather than sell them to a dealer.

Greater selling effort on the part of the individual concern is involved and different companies have varying policies in this area. War surplus sales conducted by the government following World War II can be included in this category.

Companies choosing to dispose of their surplus property, without prior decision to solicit dealers only, depend primarily on classified columns of business publications. Depending on the quantity of equipment disposed of at one time, they may also use direct mail advertising to potential buyers.

Check Your Own Organization

Another source of used equipment lies in your own organization. Some companies publish periodic lists of surplus equipment including: a brief description, a statement of condition and the location. Normally, the procedure is to place any equipment declared surplus by a plant or department on a list for a specified number of issues. If there isn't any interest after that time, the equipment is sold to dealers.

Some companies don't attempt a formal procedure notifying their own organization. While they may have valid reasons for not adopting a standard procedure, this lack can be pretty expensive.

Instances where one section of a company has items that are surplus while another is actively searching for similar items are numerous. Here's an even more costly example:

At an extremely modest price, a large corporation sold several items of rather complicated equipment to a dealer. This dealer then proceeded to sell the identical equipment to another department of the same company. Selling done at a substantial increase in price. For want of a sound surplus property procedure, many dollars were lost.

So, let's just say, if your company has a working method for cataloging available equipment—use it. If not—plug for one.

Engineering Know-How Counts

Now that we've seen why you should consider used equipment and where you can find it, is everything clear sailing from here on? No—your job has just begun.

Purchasing new equipment from a manufacturer really doesn't tax your engineering skills. In many cases, you specify the performance necessary and the manufacturer's engineering staff does most of the work. Guarantees regarding workmanship and materials are standard; performance guarantees on your process or product are common.

This situation is reversed with used equipment. Guarantees of performance are rare and warrantees against all defects are infrequent. Major exception to a warrantee against defects is when a dealer is equipped to completely overhaul and rebuild the item. Needless to say, such work adds to the price you're going to pay.

Since performance guarantees of suitability for your operation aren't usually available: deciding on the detailed specifications for the equipment is solely your responsibility.

Recommended procedure, after you've done the required engineering, is to show ranges for each critical item. For example, there may be minimum criteria for pressure, materials of construction, capacity, etc. By the same token, there may be maximum limits on physical dimensions or other aspects of the equipment.

Reason for ranges, rather than single values is the difficulty and often impossibility of locating any specific item of used equipment exactly meeting your predetermined specifications.

Inspection Is All-Important

After you've detailed your requirements and located promising items, you should make a personal inspection. Because of time and the expense of travel, this limits an initial search for equipment to a reasonable distance.

If personal inspection is difficult or impossible, purchase can be on an "as represented" basis, with the right to return the equipment if it isn't as described. Watch out here, "as represented" usually refers to the physical specifications. Condition can be considered a matter of judgment; the word "good" includes a multitude of sins.

Be sure you also include an

agreement that transportation both ways is paid by the seller if it isn't specified.

What to Look For

Here are some of the items that should be checked if you inspect before purchase. Remember, these are general suggestions applicable to various types of equipment. It's best to draw up a check-list for each item before inspection. This avoids overlooking some important detail during the visit.

- Physical dimensions
- Materials of construction
- Corrosion (particularly internal)
- Excessive wear on moving parts
- Absence of supporting members
- Damaged or misaligned openings
- Code stampings on pressure vessels

Pay particular attention to the last item on the above list. Various applicable codes, state or ASME, often impose special requirements on old units. For example, second-hand boilers are often required to have safety factors higher than those specified for new boilers.

This could result in some embarrassment if operating pressure is critical. An ostensibly satisfactory boiler (based on nameplate data) might be licensed for operation at a pressure lower than desired. Loss of wall thickness or improper modifications might negate code stampings on what was originally a satisfactory vessel.

If you've any doubts about pressure equipment, contact your insurance carrier or state inspector for recommendations before purchase.

Look carefully at the auxiliaries as well as the basic unit. For example: drives, feeders, controls and guards are often incomplete or missing. Factor this into the asking price.

In many cases, condition of the auxiliaries is as important as the basic unit—and harder to check. Instruments may be present but they may not work without a major overhaul.

Another important consideration is the suitability of the auxiliaries. This is particularly important with motors. Check nameplate data carefully to be sure it matches your power characteristics. Unless you're looking for them, watch out for 25-cycle, 2-phase or d.c. units.

Drawings and operating instructions are seldom found with equipment secured from dealers. They may be available if the unit comes directly from another concern or your own company. In any event, always try to get them with the unit. Failing this, most manufacturers will supply drawings and instructions upon request.

While obsolete designs or no-longer-existant manufacturers may not detract from the value of the equipment, for your purposes, non-availability of replacement parts should be taken into account.

Of lesser importance, but sometimes a factor in pilot plant use, is the problem of scaling-up from an archaic unit operating on abandoned principles to currently manufactured modern equipment.

Be sure to estimate all costs connected with the installation. As mentioned previously, important auxiliaries are often incomplete or missing. You may also find that openings are the wrong size or orientation for your purposes, and will require modification.

Some equipment appears to be a "bargain," perhaps due to poor condition. If repair costs are nominal, the items may well be a bargain. If not, it can get pretty expensive.

However, don't be mislead by surface appearance. Many units with scaled paint and minor rust are basically sound; cleaning and painting will take care of the aesthetics. By the same token, shiny stainless covers may hide expensive repairs.

Final Step: The Sale

Final step in the purchase of used equipment is the sale. This presents no problem if the item comes from your own company. Your accounting people will have a property transfer procedure.

Equipment purchased direct from another concern is normally bought on an "as is, where is" basis. Transportation will be to your account. Be sure to resolve the question of charges for dismantling, crating (if required) and loading. Best procedure here is to specify price f.o.b. shipping point.

You'll find some latitude in terms offered when you're purchasing from a dealer. Many dealers will, in their quotation, use language such as:

"½ cash with order, balance on removal or against shipping documents."

There are several reasons behind these terms, one of which relates to the credit position of the buyer. However, the chief reason was mentioned previously—money is the dealer's main stock. Requested terms of payment are aimed at rapid receipt of funds for use in buying.

While a dealer may often request terms similar to those quoted above, it's possible to arrange more convenient ones; for example:

"Net cash 10 to 30 days after shipment."

In addition to the quoted price of the equipment, there are often extras for items such as crating, cleaning, reconditioning and testing. Base your authorization of these additional charges on method of shipment, results of your inspection and use it will be put to.

Second-hand dealers have adopted a procedure used by equipment manufacturers; the rent-purchase plan. Normal practice is to lease equipment at a monthly rental of 10 to 20% of its selling price. Rentals are applicable to purchase. This provides similar advantages for pilot plant purposes to those secured from renting new equipment—with potentially lower costs.

One additional word about guarantees. While firm warrantees of performance in a given process are obviously outside the scope of used dealers, this doesn't mean that useful or binding guarantees can't be secured.

Most dealers are reputable and will stand behind the specifications of the equipment as they list them. For example: if a unit is sold "complete with 10-hp. motor" and then arrives sans motor or with one of 5 hp., the dealer will usually rectify the error. Correction is accomplished either by furnishing the specified motor or by an adjustment in price.

Don't ever forget that you're buying a used item. Some of its useful life is gone. How much is gone and how it'll affect your requirements is for you to decide.

If you shop wisely, there are many opportunities to save money or time by purchasing used processing equipment. But, the wise engineer also recognizes the limitations to used equipment and acts accordingly.

For Mass Transfer—Quick Method Finds

Deal with dollars directly. Get optimums quicker for distillation, absorption and extraction with this concise, ready-to-use method.

JOHN HAPPEL, Chairman, Department of Chemical Engineering, New York University, New York, N. Y.*

The economic design of distilling equipment is of special interest because distillation is the unit operation most frequently employed for separating products from a reactor system or preparing raw materials suitable for charge stocks. Because simplified methods are available for estimating the performance of distillation equipment, the economic optimum design can be reduced to a concise form. The method presented here essentially follows that originally derived by Colburn,[1] and as given elsewhere.[4]

For a given separation the greater is the reflux the fewer are the required plates or transfer units, but more steam and condenser water are needed and the diameter of the column must be larger. Here's a general solution for establishing the optimum number of trays and reflux ratio. This procedure makes design calculations easier and enables convenient approximations to be made.

How to Use the Method

A number of general solutions for the optimum number of trays and reflux ratio are plotted on the next page. These were made—some by Colburn—using Eq. (9) and the method on p. 146.

The table below gives specific values for optimum number of trays and reflux ratio for a typical set of conditions which might be found in a petroleum distillate fractionation at low pressures. For the base case assume:

- For an installed column, the cost of one additional plate with the section of tower it occupies is \$50/sq. ft. This cost is an average from several sources based on 1956 costs of towers about 5 ft. in diameter, constructed of ½-in. carbon steel. Nelson[5] gives data for comparative estimation of fractionator costs, though his values appear higher than other sources.
- Payout time = (gross investment/gross annual return): 2 years. Maintenance charges: 5% per year.
- Plate efficiency: 0.95—reasonable for hydrocarbons.
- Annual operating time: 8,320 hr. (95% of total annual time).
- Allowable vapor velocity (G_o): 15.0 lb.-mole/(hr., sq. ft.)—based on about 2 ft./sec. superficial velocity for hydrocarbon vapors. Velocity for materials such as water will be much higher—on the order of 50 lb.-mole/(hr., sq. ft.).
- Average incremental cost of condensers and reboilers: \$3/sq. ft. Heat transfer coefficient: 100 Btu./(hr., sq. ft., F.).

(*Continued on p.* 146)

Nomenclature

C_1	Amortized incremental column investment cost, \$/(sq. ft., plate, yr.).
C_2	Amortized incremental tubular equipment cost, \$/(sq. ft., yr.).
C_3	Cost of steam to vaporize and coolant to condense one lb.-mole of distillate, \$/lb.-mole distillate.
D	Distillate rate, lb.-mole/hr.
E	Fractional plate efficiency.
F	"Cost Factor" as defined in Eq. (9).
G_o	Allowable vapor velocity, lb.-mole/(hr., sq. ft.).
G_t	Vapor handling capacity of tubular equipment, lb.-mole/(hr., sq. ft.).
H	Total tubular equipment area, sq. ft.
h	Operating hours per year.
N	Number of theoretical trays.
N_o	Optimum number of trays.
R	Reflux ratio, moles of liquid returned to column per lb.-mole of distillate product.
R_o	Optimum reflux ratio.
S	Tower cross-sectional area, sq. ft.
V	Vapor rate, lb.-mole/hr.

* Meet your author on p. 177.

How Change of Conditions Affect Optimum Number of Trays & Reflux Ratio

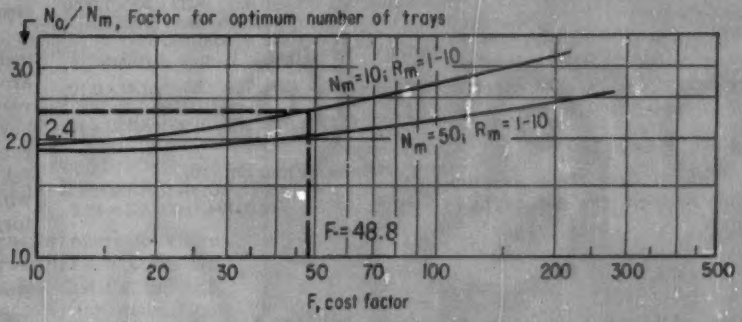
All conditions as in Base Case except with changes as noted below		Calculated F Values	Range of $\frac{N_o}{N_m}$ values when . . .			Range of $\frac{R_o}{R_m}$ values when . . .					
			$N_m=10$	$N_m=20$	$N_m=50$	$N_m=10$		$N_m=20$		$N_m=50$	
			$R_m=1$–10	$R_m=1$–10	$R_m=1$–10	$R_m=1$	$R_m=10$	$R_m=1$	$R_m=10$	$R_m=1$	$R_m=10$
Base Case		48.8	2.4	2.3	2.1	1.21	1.11	1.23	1.13	1.33	1.21
Payout time	1 yr.	29.7	2.2	2.1	1.9	1.28	1.14	1.30	1.18	1.42	1.27
Payout time	5 yr.	97.5	2.7	2.5	2.2	1.12	1.06	1.14	1.07	1.21	1.13
Steam cost	\$0.30/1,000 lb.	34.6	2.2	2.1	2.0	1.26	1.13	1.28	1.16	1.39	1.25
Steam cost	\$0.75/1,000 lb.	66.8	2.5	2.4	2.2	1.16	1.08	1.18	1.10	1.27	1.18
G_o = 50 lb.-mole/(hr., sq. ft.)		163.0	3.0	2.8	2.4	1.07	1.04	1.08	1.05	1.14	1.09

Optimum Trays and Reflux Ratio

1. Determine Cost Factor from: $F = \left(\frac{C_2}{hG_b} + C_3\right)\left(\frac{EhG_m}{C_1}\right)$ (11a)

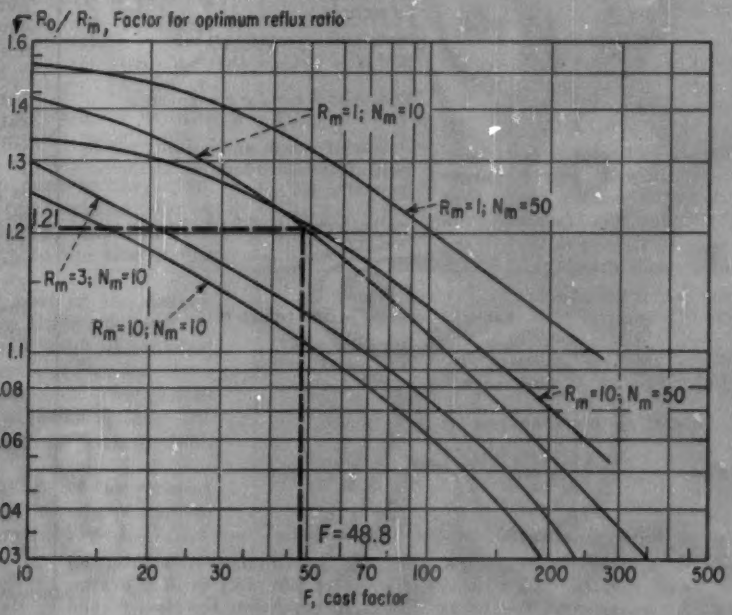
2. Enter graph at F and read N_o/N_m value.

N_m = minimum number of theoretical trays



3. Read value of R_o/R_m for calculated F.

R_m = minimum reflux ratio



4. Optimum number of theoretical trays = N_o = (N_o/N_m) (N_m)

Optimum reflux ratio = R_o = (R_o/R_m) (R_m)

• Capacity of condensing and reboiling surfaces totalled: 0.10 lb.-mole/(hr., sq. ft.). This corresponds to a molecular weight of 100 and 150 Btu./lb. latent heat.

With an assumed heat transfer coefficient of 100 Btu./(hr., sq. ft., F.) and average temperature differences in both the condenser and reboiler of 30 F., either unit separately has a capacity of: $(100 \times 30)/(150 \times 100) = 0.2$ lb.-mole/(hr., sq. ft.). Since each lb.-mole of vapor is produced by boiling one lb.-mole of feed and condensing it, the capacity per unit of *total* surface will be one-half that calculated per unit of either condenser or reboiler surface, or a value of 0.10 for this example.

• Steam cost: \$0.50/1,000 lb. Cooling water cost: \$0.02/1,000 gal. Cooling water assumed to enter at 80 F. and leave at 115 F.

Base Case Example

To illustrate how these assumptions are applied, the constants in Eq. (10), Step 1 on p. 145, will be developed for the base case.

Investment Costs — Accounting for a 2-yr. payout and 5% annual maintenance charges,

$$C_1 = 50\,[(1/2) + 0.05]$$
$$= \$27.5/(\text{sq. ft., plate, yr.})$$
$$C_2 = 3\,[(1/2) + 0.05]$$
$$= \$1.65/(\text{sq. ft., yr.})$$

Steam and Water Costs—For a heat transfer rate of $150 \times 100 = 15{,}000$ Btu./lb.-mole distillate, a latent heat of 900 Btu./lb. steam, and a water temperature rise of $(115 - 80) = 35$F.,

steam: $(15{,}000 \times 0.50) / (900 \times 1{,}000)$
$= \$0.00832/\text{lb.-mole distillate}$

water: $(15{,}000 \times 0.02) / (8.33 \times 35 \times 1{,}000)$
$= \$0.001025/\text{lb.-mole distillate}$

$C_3 = 0.00832 + 0.00103$
$= \$0.00935/\text{lb.-mole distillate}$

Other Terms—$C_2/h\,G_b = 1.65/(8{,}320 \times 0.10)$
$= 0.00199$

$C_1/E\,h\,G_a = 27.5/(0.95 \times 8{,}320 \times 15)$
$= 0.000232$

Cost Factor—From Eq. (10),

$$F = [(C_2/hG_b) + C_3]\,[EhG_a/C_1]$$
$$= 0.01134/0.000232 = 48.8$$

Derivation of Equation for Optimum Values

Determine Unit Costs

Cost of a distilling column per lb.-mole of distillate is:

$$C_1SN/EhD \quad (1)$$

But, $S = V/G_a = D(1 + R)/G_a$ (2)

Then column cost is:

$$C_1N(1 + R)/EhG_a \quad (3)$$

Condenser and reboiler costs must be included as well as fixed charges for incremental column costs. Cost of such tubular heat transfer equipment per lb.-mole of distillate can be written:

$$C_2H/hD \quad (4)$$

But, $H = V/G_b = D(1 + R)/G_b$ (5)

Then cost of tubular equipment is:

$$C_2(1 + R)/hG_b \quad (6)$$

Cost of steam and coolant per lb.-mole of distillate for feed at the boiling point is:

$$C_3V/D = C_3(1 + R) \quad (7)$$

Determine Total Costs

The total cost is the sum of (3), (6) and (7).
The rate of change of total cost with change in the reflux ratio is:

$$\frac{d(\text{cost})}{dR} = \frac{C_1N}{EhG_a} + \frac{C_1(1+R)}{EhG_a}\left(\frac{dN}{dR}\right) + \frac{C_2}{hG_b} + C_3 \quad (8)$$

The value of R_o for minimum cost is:

$$1 + R_o = \frac{N_o + [(C_2/hG_b) + C_3]\,[EhG_a/C_1]}{-(dN/dR)} = \frac{N_o + F}{-(dN/dR)} \quad (9)$$

Plot Curves From Equation

There is no convenient mathematical expression for the number of trays, N, in terms of the reflux ratio, R. Therefore solution of Eq. (9) requires a plot of N vs. R. For a general solution, this plot can be made from the curve of Gilliland.[2, 6, 8] From the plot of N vs. R, slopes are obtained at a number of points, and a curve of (dN/dR) vs. R is drawn. Then for a chosen R value, N and (dN/dR) are found, and Eq. (9) is solved for F. Finally the plots on p. 145 are made. If data for an N vs. R plot for a specific case are available, the same procedure is used.

Guides and Tips

As shown in the table, the optimum reflux ratio often is only a few percent greater than the minimum. Minimum reflux calculations depend on vapor-liquid equilibrium data and if the data's accuracy is questionable, a higher reflux ratio than indicated by economic balance should be employed. The total cost is not increased greatly by moderate increase in reflux ratio (up to 1.5 times R_m), and often an additional safety factor can be provided at little additional cost.[4]

Pyle[7] points out that for an easy separation—where only a small reflux ratio is required—liquid flow across the plate will be low. Then splashing of liquid over the weir, leakage around the vapor riser or around the edges of the weirs may result in a reduced liquid seal with lowered tray efficiency. The reflux rate under such conditions may be set by the minimum liquid rate at which the plates operate satisfactorily rather than by the economics of heat saving.

The optimum number of trays for a wide range of conditions varies from 2.0 to 3.0 times the minimum number. This suggests that a convenient, rapid approximation is to multiply the minimum number of trays from Fenske's equation[2] by 2.5 to obtain the optimum number of theoretical trays.

No generalization between number of transfer units and reflux ratio has been developed similar to Gilliland's curve for plate columns. If the curve for theoretical plates is also employed for transfer units as a reasonable approximation, Eq. (9) and the plots on p. 145 may be used by substituting C_4 for (C_1/E), where C_4 = amortized column investment cost, \$/(sq. ft., transfer unit, yr.).

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Find Number of Theoretical Stages

Apply equilibrium stage calculations shown here to mass transfer during stage-wise contacting in distillation and absorption, extraction and leaching.

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WIDELY used in mass transfer operations are stage-wise contactors. Familiar examples are plate columns of many kinds for distillation and absorption, mixer-settler contactors for extraction and leaching batteries.

In these contactors, two phases are mixed and allowed to approach equilibrium in each stage. The resulting phases then flow countercurrent to other stages for additional contacts.

Stage Gives Equilibrium

For many design problems, we can use equilibrium stage calculations. To simplify their application, we'll review the design methods for stage-wise operation. There are three parts to the design. First, we calculate the number of theoretical stages. Second, we find the stage efficiency and third, to complete the design, we determine the size of the stages from capacity correlations.

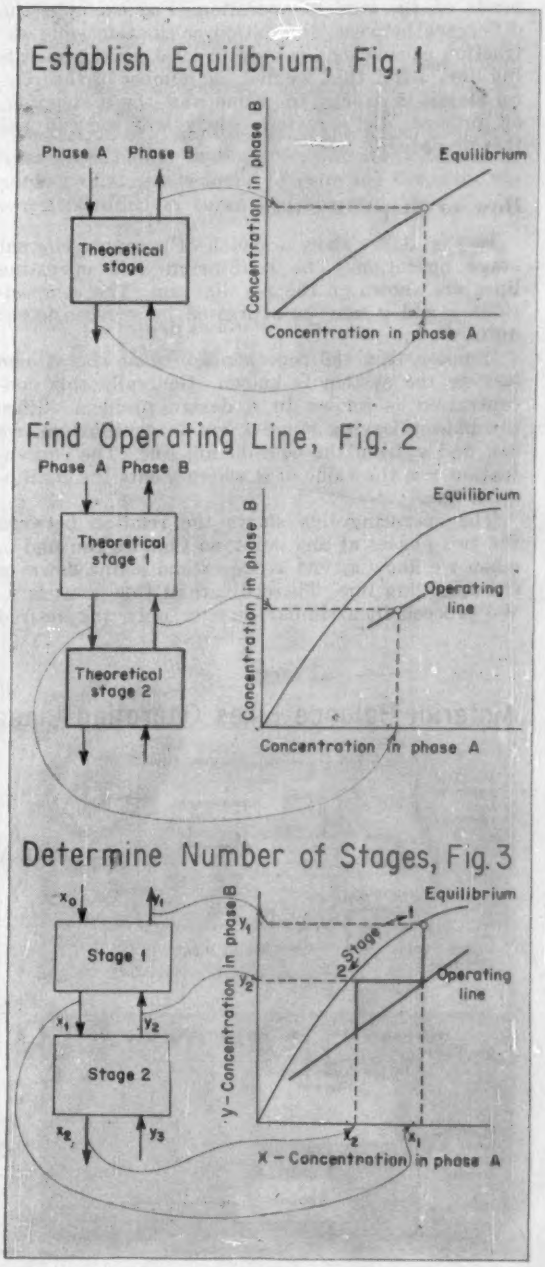
This article covers the first part of the design. In a later article, we will discuss stage efficiency.

For our purpose, then, we will think of an ideal stage as one in which two phases are mixed thoroughly until equilibrium is attained. The phases are then separated. The two streams leaving the stage are composed of two separate phases which are in equilibrium.

Therefore, the phase compositions of the streams leaving a stage correspond to a point on the equilibrium curve. We show the curve in Fig. 1.

Operating Line Is Material Balance

Stage-wise operation may be countercurrent or multiple contact. Parallel current operation is not used. After equilibrium is reached in one stage, contacting in succeeding parallel stages wouldn't do any good.



* To meet your author see *Chem. Eng.*, Mar. 24, 1958, p. 169.

Since we meet countercurrent operation most often, we'll consider this type here.

When discussing the use of mass transfer coefficients in packed towers (Chem. Eng., June 16, 1958, p. 183), we pointed out that the operating line represents a material balance. Likewise, for stage operation, the operating line shows the relation between the concentrations of the two phases at any point. So in Fig. 2, when the concentration of one phase at a point between stage 1 and stage 2 is plotted against the concentration of the other phase, we get a point on the operating line.

The relationship defining the operating line depends on the kind of operation. For example, the difference between distillation calculations and extraction calculations is only in locating the operating line. After this, we find the number of theoretical stages in exactly the same way—by a stepping-off process. Let's review briefly why we can use this procedure.

How to Step Off Stages

In Fig. 3, we show a sketch of a countercurrent stage operation. The equilibrium and operating lines are shown on the x-y diagram. The compositions x and y may be expressed in any consistent units.

Suppose that the concentration y of the stream leaving the system is known. Generally this concentration is known in a design problem. Since the phases leaving stage 1 are in equilibrium, we can find x from the equilibrium line. The concentration x is the value of x where y cuts the equilibrium line.

The operating line shows the relation between the two phases at any point, so that we can find y_2 when we know x_1. At x_1 we extend a line down to the operating line. The ordinate at this point is y_2. We proceed in a similar manner until the desired phase compositions are reached, or until we reach a side-stream. We count the number of stages on the equilibrium line, because a stage gives equilibrium.

Use McCabe-Thiele Diagram for Distillation

We can calculate equilibrium stages in distillation by the familiar McCabe-Thiele method. The assumption of equal molal overflow results in straight operating lines if mole fractions are used. Equations for these operating lines are derived in every modern textbook in chemical engineering. Here we'll only give the resulting equations and show how to use them.

For the rectifying portion of the column shown in Fig. 4, a material balance around the first n stages leads to:

$$y_{n+1} = \frac{L}{V} x_n + \frac{D}{V} y_D \qquad (1)$$

In a design problem, the reflux ratio L/V and the product composition y_D are known. The number of stages required to reduce the liquid composition to a specified value of feed composition must be calculated. These data fix the operating line, because the slope L/V and the y-intercept Dx_D/V are both known.

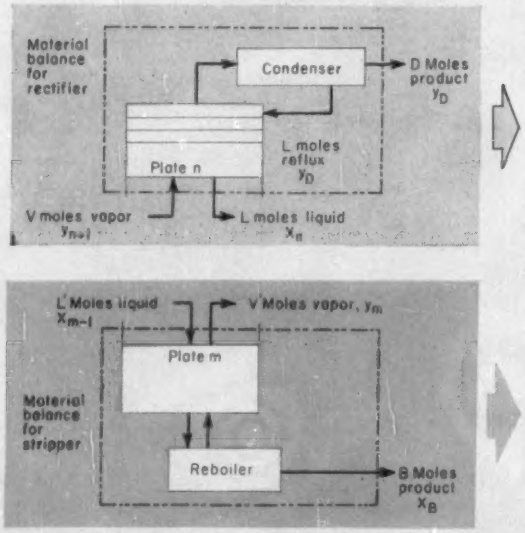
As an alternative, we may locate the point where $x = y = y_D$. From Eq. (1) and the fact that $V = L + D$, we see that the operating line passes through this point.

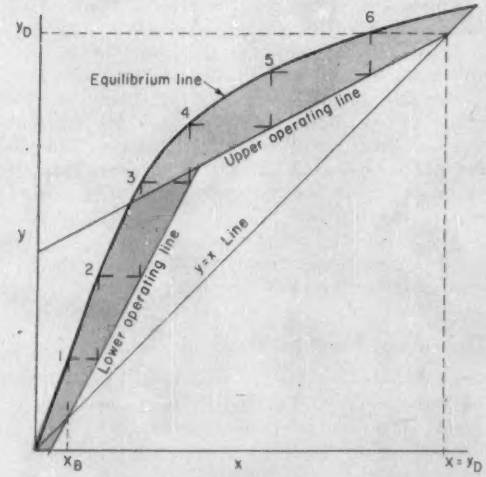
For the stripping section shown in Fig. 4, the operating line is:

$$y_{m+1} = \frac{L'}{V'} x_m - \frac{B}{V'} x_B$$

Also enough data are given by design requirements to fix this operating line. The feed stage is located at the intersection of the two operating lines.

Material Balance Fixes Operating Lines to Give Number of Stages, Fig. 4





We find the number of theoretical stages by stepping-off from the bottoms composition x_B to the distillate composition y_D as shown in Fig. 4.

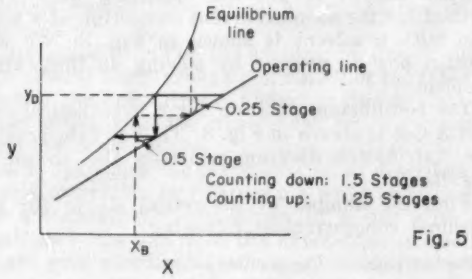


Fig. 5

Counting Fractional Stages

It is conventional to count fractions of a stage when the steps don't land on the distillate composition desired. This doesn't have theoretical justification, since we can't have a fraction of an equilibrium stage. As a matter of fact, we may get a different answer in some cases, depending on whether we count up from the bottom or down from the top. We can check this result by examining the curved operating line shown in Fig. 5 which shows the two results.

Usually the situation is not as serious as shown here. Hence little error is introduced. The error is minimized if we draw the fractional stage where the operating and equilibrium lines are most nearly straight or are closest together.

Enthalpy Balance Gives Operating Line

For distillation problems in which the simplifying assumptions of the McCabe-Thiele method can't be used, an enthalpy-concentration diagram yields the required operating line. Method of construction is shown in Fig. 6. Two curves represent the enthalpy of liquid at the boiling point and the saturated vapor as a function of concentration. Either weight or mole fractions may be used in expressing the concentration.

The point (y_{AD}) is located at $x = x_d$, the distillate composition and at an enthalpy equal to $H_D + Q/D$. The term Q/D represents the heat removed in the condenser per unit mass of distillate. A line drawn through the (y_{AD}) point will cross the vapor and liquid curves at concentrations which are coordinates of the operating line. The construction of the operating line is also shown in Fig. 6.

After constructing the operating line, we find the number of theoretical stages by stepping-off between the operating and equilibrium lines.

If the still has a stripping section, lines are drawn through point x_B, $(h_B - Q'/B)$ where Q'/B is the heat added in the still per unit mass of bottoms product. These lines for the stripping section determine the operating line as before.

Treat Liquid Extraction Like Distillation

Liquid-liquid extraction is often carried out in stage equipment. For some systems reflux is used to give better separations. This is especially true for three-component systems containing two nonconsolute pairs, such as in Fig. 7.

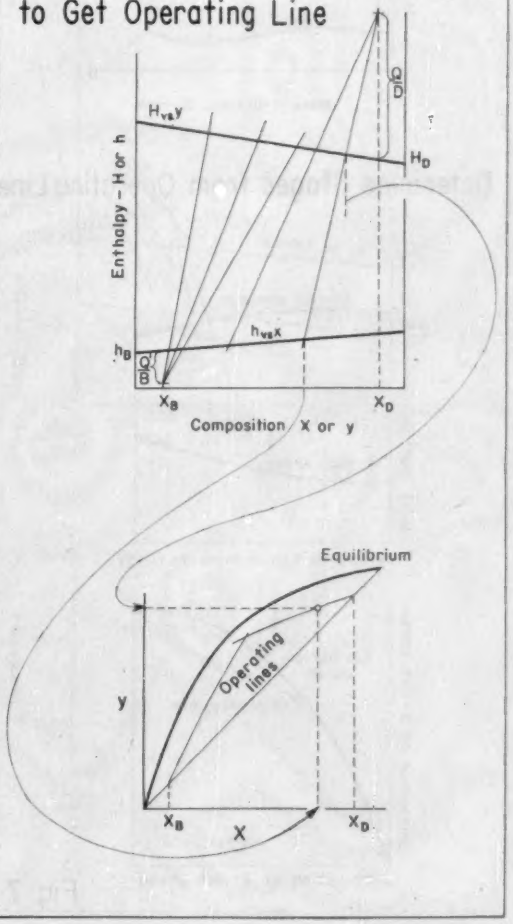
The first sketch in Fig. 7 shows how reflux is used in separating a mixture of A and B. The stream coming from the extractor is separated by some method such as distillation. One fraction contains solvent S, the other contains the overhead product. Part of this product is returned to the column as reflux.

To find the operating line, treat this extraction process exactly like distillation. The solvent S in extraction takes the place of enthalpy in distillation. We replot the equilibrium diagram as shown in Fig. 7.

The abscissa is weight fraction of A on a solvent-free basis. The ordinate is weight of S per pound of $A + B$. We locate the y_D point and draw lines through it exactly as we did for distillation. The intersection of these lines with the phase boundary lines gives points on the operating line. Hence the number of stages is found by counting the steps between equilibrium curve and operating line.

Use Enthalpy Balance to Get Operating Line

Fig. 6



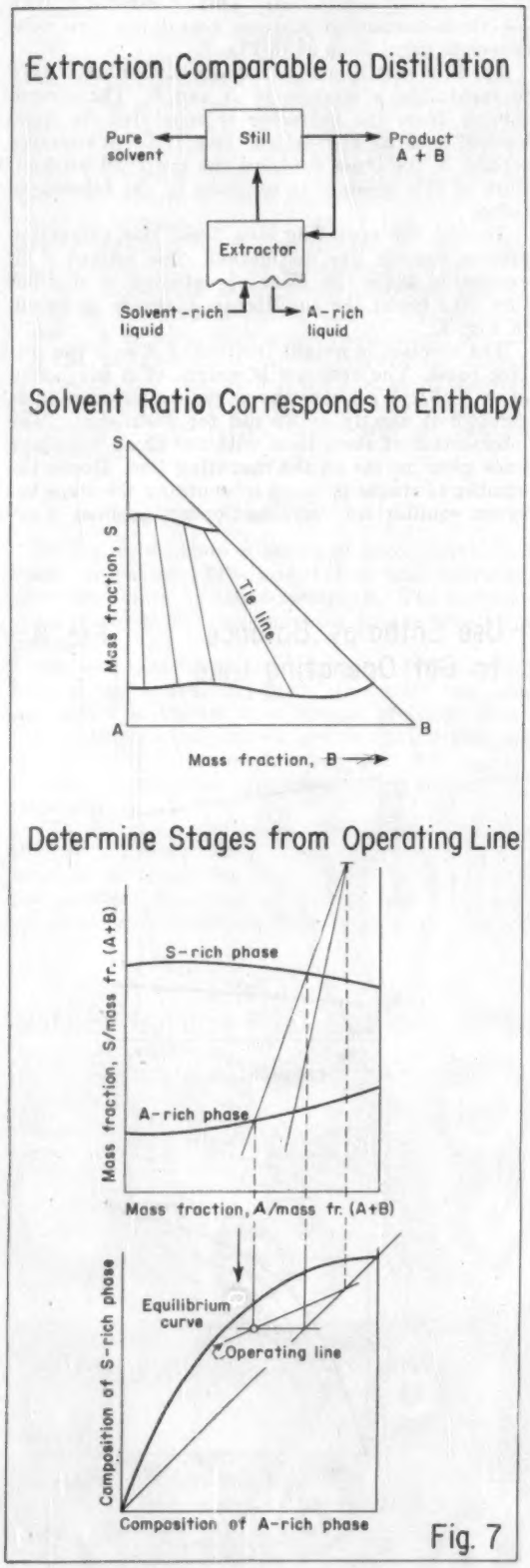


Fig. 7

Liquid Extraction Without Reflux

For the more familiar case of liquid extraction, the triangular diagram provides the material balance needed to get the operating line. This method for the countercurrent contacting of a solution with a solvent is shown in Fig. 8. We will explain how to proceed by solving an illustrative problem.

The equilibrium diagram for a hypothetical system A-C-S is shown in Fig. 8. Tie-line data provide the distribution diagram which is also shown in Fig. 8.

Find the number of theoretical stages for the terminal concentrations following:

Product stream	Composition
Fresh feed	x_o = 0.30 wt. fraction A, 0.70 wt. fraction C.
Raffinate	x_n = 0.05 wt. fraction A, saturated.
Solvent	y_{n+1} = 0.02 wt. fraction A, 0.98 wt. fraction S.
Extract	y_1 = 0.10 wt. fraction A, saturated.

To find the operating line, draw a line through x_o and y_1. Also draw one through x_n and y_{n+1}. Their intersection gives the Δ-point. Other lines drawn through this intersection cut the phase boundaries at points which are coordinates of points on the operating line.

Now replot the operating line on the distribution diagram. Using this diagram, step off the number of theoretical stages. This number is 2.1.

Leaching Calculations Are Similar

The only real difference in leaching calculations is in the nature of the equilibrium. For leaching, the equilibrium between the underflow leaving a stage and the overflow leaving the same stage depends on the retention of liquid by the underflow solids. From retention data, we can plot an underflow line (see illustrative problem) showing all possible underflow compositions. The overflow contains solids-free solution, and the compositions of such solutions form the hypotenuse of the triangular diagram for the system.

Problem Illustrates Leaching

Suppose we wish to find the number of theoretical stages required for these conditions:

Fresh solids:	0.15 lb. solute/lb. dry solids; no solvent
Spent solids:	0.01 lb. solute/lb. dry solids.
Solvent:	Contains no solute.
Strong solution:	10% solute; no solids.

Underflow from each stage contains 1.5 lb. solution/lb. dry solids.

First, draw the triangular diagram and locate the terminal compositions as shown in Fig. 9. We locate the underflow line by assuming a few solution compositions and calculating the composition of the underflow for each. The solute is A, the solvent S and the solids B.

For 1 lb. of solid B, the solution weight is 1.5 lb., and the total weight 2.5 lb. Therefore, the fraction of B is constant at 1/2.5 or 0.4 weight fraction.

The underflow line is drawn along constant x_B where x_B equals 0.4.

The underflow from a stage is made up of a mixture of the overflow from the stage and dry solids, represented by the apex B. Therefore, equilibrium compositions are on a straight line drawn through point B.

Establish points on the equilibrium line by drawing several lines through point B. Plot the intersection of the line with the underflow line against the intersection with the hypotenuse which represents overflow compositions.

The operating line is constructed as described for liquid extraction by locating a Δ-point and drawing lines through it. Intersection of a line with the underflow line and with the hypotenuse of the triangle give coordinates of an operating-line point.

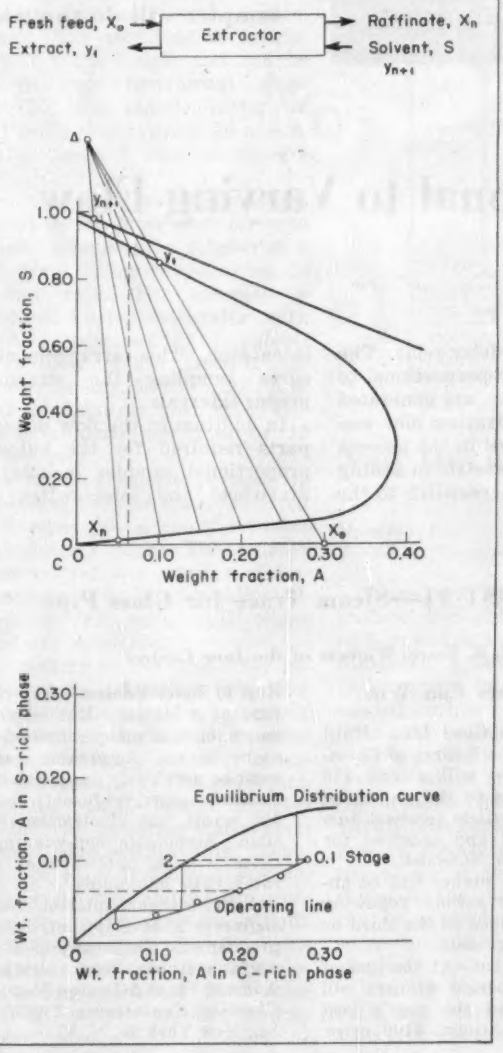
The operating and equilibrium lines are shown in Fig. 9 where the required number of stages for the problem is 2.6.

Coming: Stages in Packed Towers

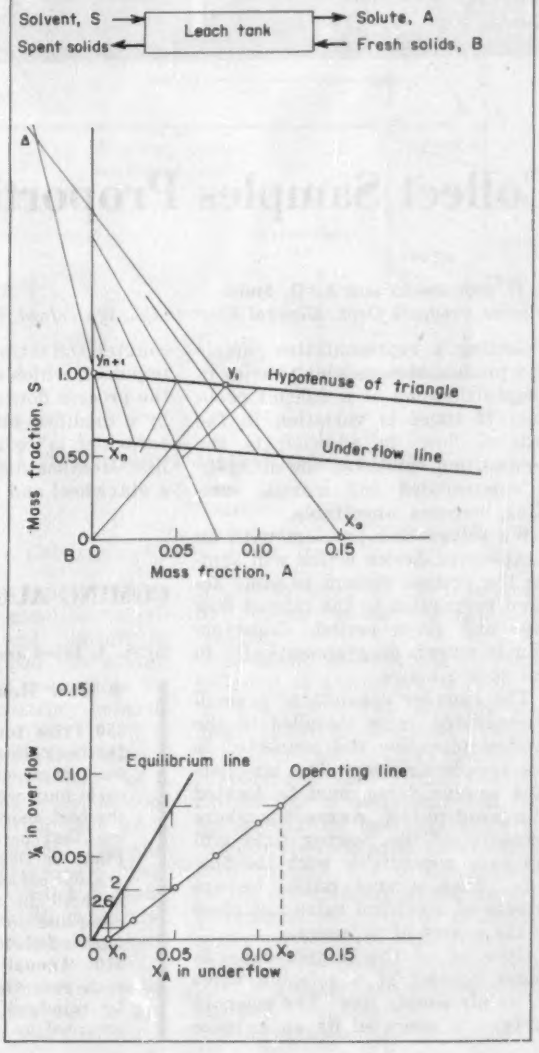
Packed towers were formerly designed by finding the number of theoretical stages. Packing efficiency is expressed as the height of a theoretical stage (H.E.T.S.). Then required tower height is the product of the number of stages and the H.E.T.S.

This procedure doesn't have a sound basis, since there aren't stages in a packed tower where we get equilibrium. It has been replaced largely by the transfer unit method which we'll discuss in our next article.

Liquid Extraction - No Reflux Fig. 8



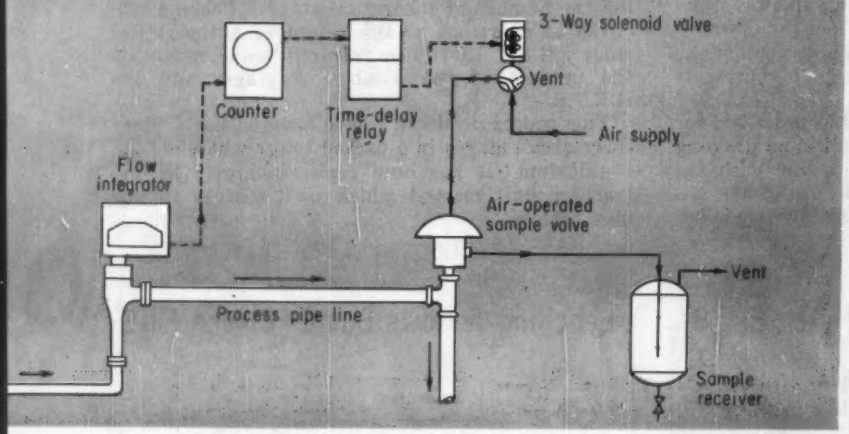
Leaching Follows Same Pattern Fig. 9



PRACTICE . . .

PLANT NOTEBOOK

EDITED BY T. R. OLIVE



When a process stream varies in both composition and flow rate, a flow-proportional sampler will do the trick.

Collect Samples Proportional to Varying Flow

D. D. Stepnewski and K. D. Smith
Silicone Products Dept., General Electric Co., Waterford, N. Y.

Getting a representative sample of a process stream which varies in composition can be a difficult problem. If there is variation in the rate of flow, in addition to the composition variation, the difficulty is compounded and manual sampling becomes unsuitable.

We solved this problem with an inexpensive device which will sample the process stream in some desired proportion to the rate of flow over any given period. Construction is shown diagrammatically in the sketch above.

The sampler consists of a small air-operated valve installed in the process pipe line and connected to the sample receiver. The air-operated sample valve must be located at a point in the process line where pressure of the flowing fluid will not vary appreciably with the flow rate. Such a spot might be upstream of a control valve and close to the source of pressure.

Opening of the sample valve is under control of a solenoid valve in its air supply line. The solenoid in turn is operated by an impulse counter and a time-delay relay. The impulses, which are proportional to the process flow rate, are generated by a modified integrating flow meter which is installed in the process line. Modification consists in adding a starwheel and microswitch to the integrator. This arrangement insures sampling the stream at proper intervals.

In addition to the flow meter the parts required for the automatic proportional sampler include: (1) Starwheel and microswitch; (2)

COMING AUGUST 11—Steam Trace for Glass Pipe

By A. A. Fried and J. R. Scace, Winners of the June Contest

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustration if possible. Acceptable non-winning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

Sample Recovered in 8 Hr. at Various Flow Rates

Flow Rate, Lb./Hr.	Impulses, No./Min.	Time per Sample, 100 Counts, Min.	Sample Accumulation, Cc. in 8 Hr.
5,000	24	4.2	1,030
3,000	14.4	6.9	625
1,000	4.8	21.0	206

impulse counter (e.g., Eagle Switch Corp.'s Microflex Counter); (3) time-delay relay (e.g., Allen-Bradley Bulletin 849); (4) three-way solenoid valve; (5) miniature diaphragm motor valve (e.g., Dahl 5000 series).

Items (1), (2) and (4) in the list are components of a conventional batch control system and can probably be bought from the instrument company making the flow integrator. The addition of a time-delay relay (Item 3) is a deviation from conventional batch control systems. The modification in circuitry is quite simple and can be done in your instrument shop. Item (5), the sample valve, we found could conveniently be a ¼-in. angle bottom-port Dahl diaphragm valve.

The starwheel and microswitch installed in the integrator serve to generate impulses, the number in a given time being proportional to the flow rate. For example, a Fischer & Porter integrator with starwheel produces 24 impulses/min. at full-scale flow. Thus, if full-scale flow is, say, 5,000 lb./hr., producing 24 impulses, then 2,500 lb./hr. will produce half that or 12 impulses/min.

The impulse counter counts up the number of impulses received and at some preset count actuates the time-delay relay. The counter can be set for any number of impulses from 0 to 400 typically—although models with still wider ranges are available.

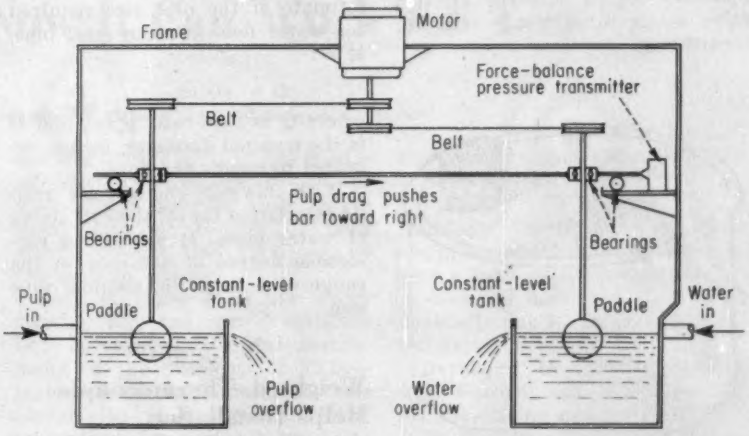
The setting of the time-delay relay serves to determine how long the sampling valve will remain open each time the impulse counter sends it a signal. This relay is adjustable from 1/6 to 180 sec. which means that each counter impulse can hold the sampling valve open for any time within this range.

Size of each individual sample, of course, depends on both the pressure drop in the sampling circuit and on the duration of valve opening. In our particular case a time-delay setting of 6 sec. would deliver 9 cc. of sample to the sample receiver.

The time-delay relay energizes the solenoid valve which in turn applies air pressure to the sampling valve diaphragm for the time set in the relay. At the end of this time the three-way solenoid valve cuts off and vents the diaphragm so as to close the sampling valve immediately. At the same time the time-delay relay resets the counter to zero.

In our case the counter was set to give a valve-opening impulse every 100 counts. At this rate, and with the other constants mentioned, the sample accumulated in an 8-hr. shift at various flow rates is calculated to be as shown in the table.

This sampler can be installed for about $500 plus the cost of the flow meter and integrator. If the latter must also be purchased the total will be increased by an additional $600.



Null Device Controls Pulp Consistency

Massimo Rosicarelli
Technical Supervisor, Cartiere di Verona, Milan, Italy.

There are many types of controllers for pulp consistency, all rather expensive and difficult to construct. I developed the design shown above in one case where we needed such a consistency controller rather urgently.

This device is of the null-balance type in which the consistency of a continuously flowing pulp is constantly compared with that of a flowing stream of water. The signal produced is therefore proportional to the pulp consistency and can be applied to a dilution valve so as to hold the consistency constant.

Use of the water comparison rules out inaccuracies due to line voltage fluctuations and also makes it easy to "zero in" the instrument by flowing water through both troughs.

A small constant-speed motor mounted on a steel frame over two troughs drives two identical paddles through identical pulleys, V-belts and shafts. The paddles are supported in anti-friction bearings carried by a horizontal rod supported on roller bearings. When the paddles are rotated in the constant-level troughs, the power absorbed by the one rotating in the water is a constant, proportional to the viscosity of water. The power absorbed by the paddle rotating in the pulp is greater, and will vary with the pulp consistency.

Now, consider how the power ab-

sorbed by the two paddles is continuously compared. The tension in each of the V-belts is proportional to the power it is transmitting. Since the pulp is absorbing more power, the belt driving the pulp paddle will be under greater tension and so the rod supporting the paddles will tend to move in the direction of the arrow. However, its motion is opposed by a conventional force-balance transmitter of the pneumatic type which restores the bar to the null position at the same time sending a pneumatic signal proportional to the difference in consistencies of the pulp and water streams.

This pneumatic signal is then applied to a conventional three-mode controller which sets the dilution valve so as to maintain constant consistency.

Dry Ice Lumps Decrease Fire Hazard

E. J. Barnes and W. J. Huber
Production Foremen
Schering Corp., Bloomfield, N. J.

In transferring hot, flammable solvents in small open vessels, such as nutsche filters, open tanks and transfer dollies, there is an ever-present fire hazard due to static electricity. Of course, the proper precautions should be taken by using static lines to guard against such fires. But their possibility can be still further reduced by the following simple method of blanketing the solvent.

Make a "soap dish" out of wire cloth and hang it over the rim of the vessel receiving the hot solvent. Putting a few chunks of dry ice in this container will serve to cover the liquid surface in the vessel with a blanket of CO_2. This will cut down the possibility of ignition of the solvent vapors and at the same time will condense some of the fumes as they come in contact with the dry ice.

Rule-of-Thumb Finds Water Pipe Size

William Resnick
Chicago, Ill.

Here is an equation—or, more accurately, a rule-of-thumb—which I should like to add to Maxey Brooke's extensive series of flow formulas which *Chemical Engineering* carried throughout 1957.

This equation permits a quick estimate of the pipe size required for water flow in clean steel pipe. It is:

$$D = \sqrt{Q/10}$$

where Q is flow rate, gpm., and D is the nominal diameter, inches, required to handle the flow.

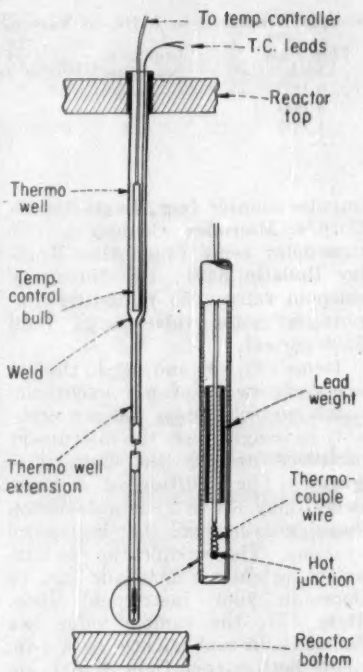
With this rule one can use mental calculation for off-the-cuff sizing of water pipes. It provides a reasonable degree of accuracy in the range of 1 to 10 in. nominal pipe size.

Weighted Thermocouple Helps Installation

Javier F. Kuong
Technical Assistant, Polyol Dept.
Atlas Powder Co., Wilmington, Del.

In the course of measuring longitudinal temperature profiles in a tall, high-pressure reactor I encountered difficulty in introducing a thin thermocouple wire into the long thermowell without causing it to kink or coil.

The thin thermocouple was needed because, in order to keep the reaction under control, it was necessary to keep the existing thermometer controller bulb in place. After adding an extension to the thermowell as shown in the sketch there was little space between the bulb and the wall of the thermowell through which to thread the new thermocouple. The lack of stiffness of the thermocouple wire then made it impossible to reach the bottom of the well extension due to kinking and bending. Hence it was impossible to measure temperature at the bottom



of the reactor, which was important to the experiment.

A piece of lead attached to the thermocouple wires near the hot junction solved this problem. The lead consisted of a small rectangular sheet wrapped around the insulated portion of the thermocouple wire about ½ in. from the tip. It was compressed and then filed to fit and slide freely within the thermowell as shown in the detail sketch.

When this was done the thermocouple wire easily slid down the thermowell without kinking or bending. Therefore we were able to measure the temperature at the extreme bottom of the reactor and, by lifting the thermocouple at measured intervals, to determine the desired temperature profile. Since the thin wire could easily slide between the temperature bulb and the well wall, there was no problem in raising the hot junction smoothly to measure temperatures at various levels.

The thermocouple was installed during operation of the reactor without upsetting control by withdrawing the controller bulb for a few seconds while the thermocouple was slid into the well. When it reached the bottom the bulb was quickly replaced without disturbance.

"It is not really important to you as a technical man that brainstorming is called brainstorming, or that it was originated by an advertising man. The important thing is whether or not the technique has any value in scientific and engineering work."

Brainstorming: Now It Can Work for You

JOSEPH C. MASON, Batten, Barton, Durstine & Osborn, Inc., Minneapolis, Minn.*

When the Atlas missile put our first Explorer satellite into orbit, American technology moved irreversibly—if somewhat belatedly—into the realm of 18,000-mph. speeds. In spite of the wishes of many people, we can never go back to the relative horse-and-buggy days of even 10 yrs. ago when the fastest man-made machines moved at the leisurely pace of 500-600 mph.

The age of space speeds is here and we have to learn to live with it.

This means that we also have to gear ourselves to new speeds in thinking and problem-solving. Even pre-Explorer, our scientific problems were so complex that it was a rare individual who knew all there was to know about even one of the specialties within a specialty—let alone, a complete science.

And, of course, our complex sciences are creating problems just as complex. Nearly gone are the days when a lone scientist can suggest a "simple change" that will immediately solve a major chemical or processing problem.

We just don't use chemicals and equipment that way anymore!

Research, development, production and management people frequently find that today no one man has the knowledge or experience required to solve the "super problems" that are coming up. Individualists say the solution lies in educating our scientists better, or more. Or in teaching them to use more than the 15-20% of their mental powers that they use, on the average, today.

Both of these goals are worth striving for, and should certainly be encouraged. Unfortunately, many of the problems of 18,000-mph. science can't wait for the human element to catch up. Not if a company (or nation!) wants to stay in business. And with technologies increasing at an estimated rate of 20% a year, it seems somewhat doubtful that we can catch up using only improvement of the individual.

Team Effort: Only a Partial Answer

The scientific team of two or three men has provided a partial answer to this. But even teams now find their joint imaginative efforts inadequate at times.

So, more and more, we are being forced to turn to group efforts to come up with ideas and answers—particularly when those ideas and answers are needed in a hurry. One of the better-known methods under experiment is that known as brainstorming.

Actually, brainstorming is probably one of the most misunderstood—therefore, unappreciated—group techniques as far as scientists and engineers are concerned. They tend to look down on it as a product of commercial hucksterism, fit only for extrovertic advertising and sales-promotion men.

Part of this attitude is undoubtedly due to the name brainstorming, which does in a way suggest a flash-in-the-pan approach to problem solving. Part of its is undoubtedly due to the origins of the technique.

Developed by advertising man Alex Osborn, and introduced into his advertising agency (BBDO) in 1939, brainstorming more or less cut its teeth on promotional problems. And it was the advertising and promotional staffs of BBDO's clients who were the first "outsiders" to be exposed to the technique and who began to spread its use.

Therefore, brainstorming's history is replete with new product names, supermarket promotional ideas and wing-ding, razzle-dazzle and whoopdee-dos which, though they did solve problems for people who needed just such ideas, did not contribute anything to gaining respect for the technique among more conservative minds.

It is not really important to a technical man that brainstorming is called brainstorming, or that it was originated by an advertising man, or that its chief advocates are still promotional types. The only thing that is important is whether or not the technique has any value in scientific and engineering work. Some scientists and engineers believe it does.

* Meet your author on p. 178.

How Brainstorming Can Be Adapted for Technical Use

Method 1

1. There must be a procedure accepted throughout the company for selecting participants in brainstorming sessions:
   - All possible participants should be trained in the technique.
   - There should be a "central roster of skills" which can be referred to in drawing panelists for any particular problem.
2. On more complex problems, consider right from the start two sessions using the same panel of participating brainstormers:
   - At the first session, the originator of the problem would meet with the panel to define the general problem and to answer questions. Next, the group would brainstorm "openly and wildly." Following this, the originator of the problem hands out a "brief" containing technical requirements and a bibliography of the specific problem.
   - At the second session—to be scheduled two to three weeks later, to allow time for thorough study of the problem—the panel brainstorms the problem in earnest. If the problem is overly complex, they may use the "stop-and-go" technique. This is a refinement of brainstorming that uses alternating periods of thinking up ideas and evaluating progress under strict moderater control. However, this technique should not be attempted with first-time brainstormers or an inexperienced moderator.
3. After he evaluates the ideas produced in both sessions, the originator of the problem reports back to the panelists on results. If he has not been able to develop a solution to the problem, he may ask for a repeat session.

Method 2

1. There must be an organized system of panel selection, including a roster of skills for use in drawing panelists.
2. Orientation of the problem must be done by the man who has the problem. He should have enough understanding of brainstorming to develop a problem statement on a specific of the general problem.
3. This group also recommends a two-session attack:
   - The first session would consist of verbal briefing by the man with the problem, followed by a group brainstorm.
   - At the conclusion of the first session, a printed briefing would be given to each panel member and a second session of the same panel would be held 2 or 3 days after the first for additional ideas.
4. Problem originator would be one of a two- or three-man team to evaluate all the ideas that have been generated.

Method 3

1. This group suggested using a team of two or three men to define and prepare the problem for brainstorming. They may, at this step, solve it. If not, the team selects the brainstorm-panel members and appoints a chairman.
2. At a preliminary panel meeting, the team presents the problems, answers questions and supplies any necessary printed briefing. Following this, allow for a 2- to 3-day incubation period.
3. At the second panel meeting, members either brainstorm or "buzz" the problem, depending upon the specific nature of the problem:
   - Brainstorming would be used when what was wanted was a good list of alternatives for study.
   - The buzz technique would be preferred if the problem were something that required evaluation or a decision. It would be used by breaking the 12-14 panelists into three or four smaller groups. Buzzing is a technique that allows free discussion in a positive, constructive sense, with a definite deadline set for reaching a group recommendation.
4. When either the brainstormed ideas or the independent buzz reports are turned in, the original team acts as an evaluating committee to screen ideas and to recommend or initiate action.
5. Team reports back to panel members with results.

Here Are the Basics

There are a few basics that must be understood before you can objectively evaluate (and intelligently use!) brainstorming on scientific problems.

The first thing to remember is that the objective is to help get ideas that will solve problems. Not ideas for the sake of ideas, but ideas to solve problems we consider worth solving.

Secondly, anything we can do to get those needed ideas is fair play. Used in this sense, brainstorming in no way competes with the individual. Instead, it adds one more tool to the individual's kit for producing ideas. (You can, of course, substitute "team" or "lab group" for "individual" without harming this premise.) Just as with any other tool, you have to learn how to use brainstorming and you have to know when it is the best tool for the job at hand.

Brainstorming has never been recommended by Alex Osborn—or by anyone else with a real understanding of the technique—as the only way to solve problems, or as something that should be used on every problem. But it is a good technique for certain types of problems.

Where It Can Help You

Here are some general classes of problems where brainstorming might be of help to you as a chemical engineer:

- For quickly compiling alternatives. It is characteristic of problems that are open to imaginative solution that there are many possible courses of action. A brainstorming session can give you an exhaustive list of these, in a relatively short time. At least, this can give you a start on the problem.
- As a crash-program, knowledge-pooling device. After all, brainstorming is primarily an orderly method for concentrating the knowledge, experience and imaginative abilities of a group of people against a problem. By setting up a panel comprising a variety of specialists, you may be able to save time and effort in pooling available knowledge on a problem.

In this case the noncritical rule of brainstorming serves to streamline the conduct of the meeting. Used in this way, you should not expect brainstorming to produce

ideas, although you may get some of them as byproducts.

• As an exploratory technique for new products or methods. One major company in the chemical industry uses brainstorming this way: when a new chemical or seemingly promising material is developed, they assemble a panel of development men and brainstorm for possible new products they could make or for possible replacements in present products.

The ideas developed are considered only as starters, and the whole list is turned back to a lab group for evaluation and exploration. Sometimes development reports a complete blank. However, this does not mean that the brainstorm was a failure. It simply means that as of that time there were probably no immediate uses for the material.

• To explore possibilities for product or process improvement. You can challenge a brainstorm panel to suggest specific improvements in function, performance, operations, maintenance, sales and cost control.

• As a group test. This may well be one of the most efficient and productive uses of brainstorming on scientific problems. Interestingly enough, individual or team effort on the problem is almost a prerequisite to the brainstorm.

The way it works is this: When an individual has what he believes is a feasible solution to a problem, he presents the problem and his solution to a panel. The group then tries to suggest improvements on the proposal. To evaluate the ideas, they are measured against the original solution on the standard counts of costs, function, dependability, etc.

It's possible that the brainstorm will not yield any improvements at all. But in the group test, a decision of "no changes" is still a positive and worthwhile answer.

• To find new approaches to existing problems. One engineering group had been trying for over two years to lick one specific problem. Finally, in what he admits was a "last resort" attitude, an engineering manager called in some of his engineers to brainstorm the problem. None of the panel had previously worked on this problem.

In 45 minutes they produced about 75 ideas, including every one that had been tried in the previous two years plus "four or five new ones that offer distinct possibilities."

When asked if he thought that by holding a brainstorming session two years earlier he would have saved that amount of time, his answer was, "Maybe, but probably not. We couldn't have defined our problem as well then."

The Problem Must Be Right

This points up and, at the same time, confirms one of the most misunderstood things about brainstorming: The problem must be right before a brainstorm session can pay off.

There is enough in print about brainstorming* that we won't go into how you set up and run sessions. However, there is not much information available on how you set up and maintain brainstorming as a regular operation in a research or development organization.

In an effort to develop such a system, one large midwestern chemical company recently turned to a class of their research and development men who were participating in a course in "Creative Problem Solving." As part of the course, these men had been exposed to several group creative techniques and had roughly evaluated the various methods for possible adaptations to their scientific problems. Most of these problems were chemical or production control in nature.

Build a Framework

One of the exploratory problems given to the group was, "How can we improve or modify brainstorming to make it suitable for our technical problems?" Without even consulting the instructor, the group decided that the brainstorm technique was a good enough tool and that the problem really should have been worded "How can we process technical problems to make them suitable for brainstorming?"

The class was divided into three groups and each group proceeded to develop a suggested framework for fitting brainstorming into regular research and development functions. We have reported these three plans of attack on the previous page. By studying them, you will probably find a pattern that might be close enough to apply to your own job.

After submission of group reports, there was a general class discussion of the whole subject of group creative work. As a result of the reports and the discussion, we can propose some general observations on the use of brainstorming in technical organizations.

1. There was no question about the acceptance of brainstorming as a valuable tool by this group. Their prime interest in it seemed to be in the "time-compression" feature. Brainstorming gives them a means of quickly compiling a list of alternatives they can use to "get going" on a problem.

2. There was a definite feeling expressed that technical men probably need special indoctrination and practice in brainstorming before they try to use it seriously.

3. Because of the complexity of technical problems, it was felt that an integral part of the company program should be an available "roster of skills" and that the panel selector should be free to draw upon anyone—regardless of rank—if his previous experience indicates he could contribute.

4. There was a definite feeling that a brainstorming procedure should be formalized as a company practice, even to the extent of a management-approved "manual" of operations.

5. A team was decided upon as the desirable alternative to individual processing of problems. In this particular organization the standard working unit is a team of two or three men. Giving the team full responsibility throughout the problem-solving sequence does not, therefore, represent too great a departure from normal procedure in this company.

Getting back to one of the basic premises of brainstorming, we can conclude that scientists and engineers who have taken the time to learn it, understand it and to gain experience in using it, recognize it for what it is: a tool for getting ideas using as raw material the memories and mental powers of other people.

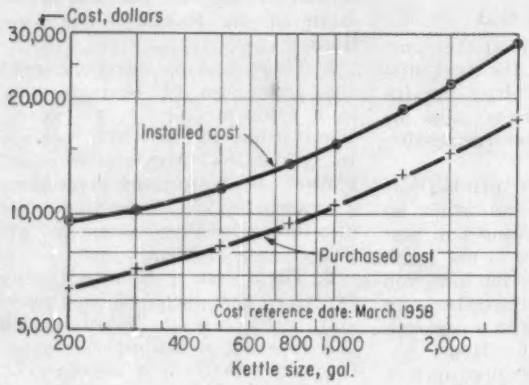
Brainstorming is no panacea, no cure-all. But it is a tool that, if used imaginatively, can produce new ideas for you.

* "Applied Imagination," by Alex F. Osborn; "Brainstorming," by Charles H. Clark. Also, information is available without charge from the Creative Education Foundation, 1614 Band Building, Buffalo 8, N. Y.

By Harold Gushin,
General Aniline & Film Corp., Linden, N. J.

Cost of Process Vessels

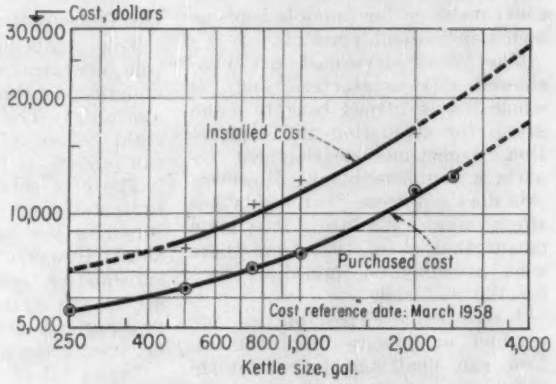
Glass-Lined Kettles



Purchased cost includes: kettle, jacket, agitator, thermometer well, drive & support, manhole cover, stuffing box and clamps where necessary.

Installed cost includes: above plus installation costs (labor, material and overhead), design and expense. No piping, structural changes, instrumentation or electrical charges are included.

Cast Iron Jacketed Kettles

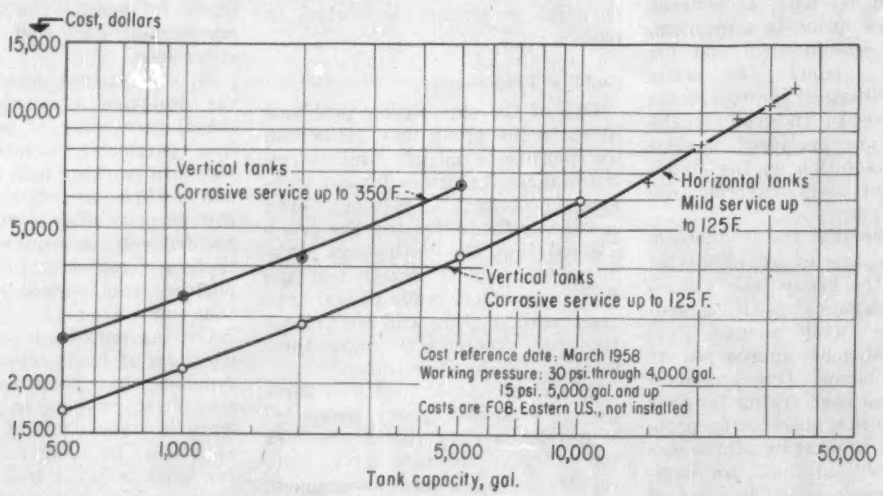


Normal working pressure: Kettle and jacket: 100 psi

Purchased cost includes: kettle, jacket, agitator, thermometer well, drive & support, manhole cover, stuffing box and clamps where necessary.

Installed cost includes: above plus installation costs (labor, material and overhead), design and expense. No piping, structural changes, instrumentation or electrical charges are included.

Glass-Lined Tanks

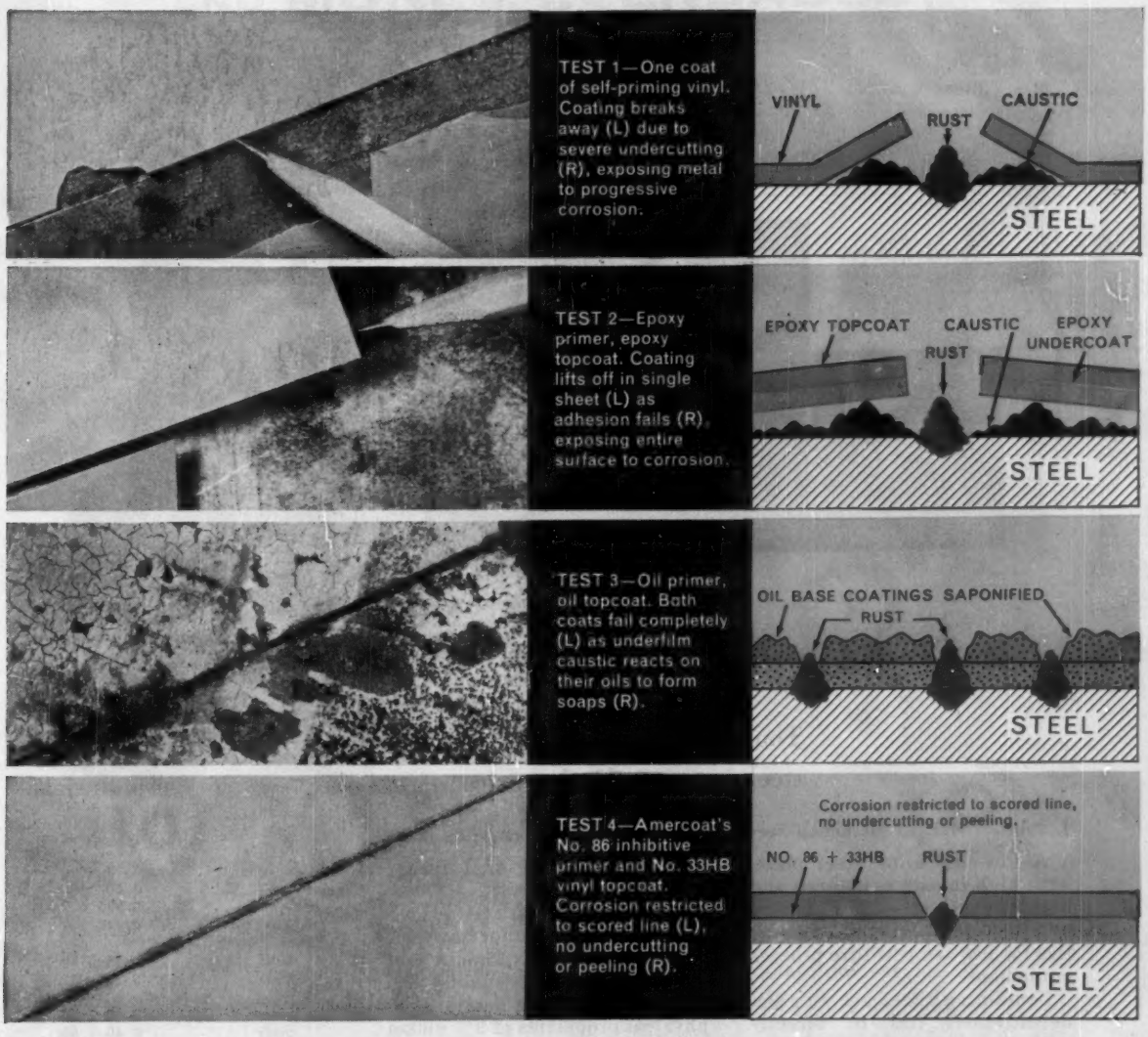


Let Us Hear From You

Send your cost data, preferably in tabular or graphical form and with a minimum of text, to CE Cost File Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. Any legible form is acceptable. We will pay regular space rates for all published material.

PUZZLED ABOUT PRIMERS?

Here are tests you can duplicate


TEST 1—One coat of self-priming vinyl. Coating breaks away (L) due to severe undercutting (R), exposing metal to progressive corrosion.
VINYL
RUST
CAUSTIC
STEEL
TEST 2—Epoxy primer, epoxy topcoat. Coating lifts off in single sheet (L) as adhesion fails (R), exposing entire surface to corrosion.
EPOXY TOPCOAT
CAUSTIC
RUST
EPOXY UNDERCOAT
STEEL
TEST 3—Oil primer, oil topcoat. Both coats fail completely (L) as underfilm caustic reacts on their oils to form soaps (R).
OIL BASE COATINGS SAPONIFIED
RUST
STEEL
TEST 4—Amercoat's No. 86 inhibitive primer and No. 33HB vinyl topcoat. Corrosion restricted to scored line (L), no undercutting or peeling (R).
Corrosion restricted to scored line, no undercutting or peeling.
NO. 86 + 33HB
RUST
STEEL

The purpose of these accelerated tests is to show what happens when various types of coatings are exposed to a typical corrosive environment. Four clean steel panels, free from mill scale and rust, were coated with different combinations of primers and topcoats. Each was scribed to bare metal and immersed in salt water in the presence of free oxygen, for two weeks.

As caustic deposits formed over cathodic areas of the steel in tests 1, 2 and 3, failure occurred in three ways. The vinyl, though not directly attacked, was undercut as caustic spread beneath the film and destroyed adhesion. The epoxy coating, known for critical adhesion to smooth metal, proved impervious to caustic attack. It was, however, lifted in its entirety as moisture spread beneath the surface. The entire oil paint film was quickly penetrated by the salt solution, creating widespread corrosion and caustic formation. The caustic then reacted with the oil to saponify the film.

In the fourth test the corrosion was limited to the score mark. Reason: Amercoat No. 86 Primer resists undercutting and adheres tenaciously, inhibiting electrolytic corrosive action.

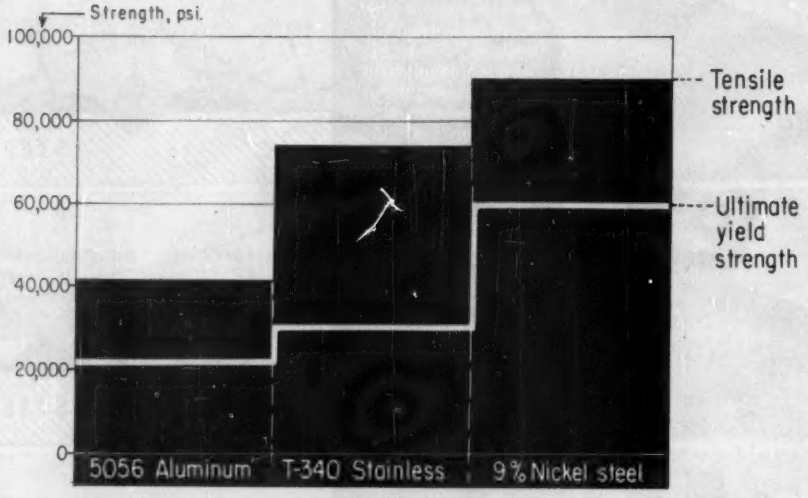
The conclusions are clear. To provide long term protection in corrosive service, start with Amercoat No. 86 Primer, which provides a sound and lasting base for quality topcoats such as Amercoat No. 33HB.

Write today for complete data on Amercoat No. 86, and have the details on hand when planning your next important coating job.

Amercoat CORPORATION

109 Dept. AG

4809 Firestone Blvd., South Gate, Calif.



Low-Cost Cryogenic Steel Goes Commercial

Tough and strong at low temperatures, this new 9% nickel steel is one-half the price of standard cryogenic materials.

J. Procter, Mgr. of Marketing Service, Lukens Steel Co., Coatesville, Pa.*

A low-cost alloy steel plate, with high impact resistance and high strength at −320 F. is now available in commercial quantities for low-temperature process equipment.

Containing 9% nickel, this new development ties in directly with the present plentiful supply of nickel. Information was available shortly after World War II indicating that a high-nickel steel has excellent low-temperature properties. A small amount was produced at that time, but large-scale production was not possible because of the nickel shortage.

▶Should Become Popular—Proved in liquid oxygen and liquid nitrogen storage and regenerator equipment, producers of the new alloy are looking to widespread use in low-temperature service, now that nickel is readily available.

Plates and heads are priced about 50% below other low-temperature metals (stainless and aluminum). But equally as important are the outstanding physical properties of 9% nickel steel.

We decided in 1957 to produce a commercial quantity of the metal for evaluation of properties and economics. Up until then only a limited amount of such data was available.

The steel was produced to ASTM specification A-353, adopted in 1956. You will also find that the 1956 ASME Unfired Pressure Vessel Code, section 8, also recommends the steel for low-temperature service.

The A-353 specification calls for the following chemical analysis:

C, max.%	0.13
Mn, max.%	0.80
P, max.%	0.035
S, max. %	0.040
Si,%	
ladle	0.15–0.30
check	0.13–0.32
Ni,%	
ladle	8.50–9.50
check	8.40–9.60

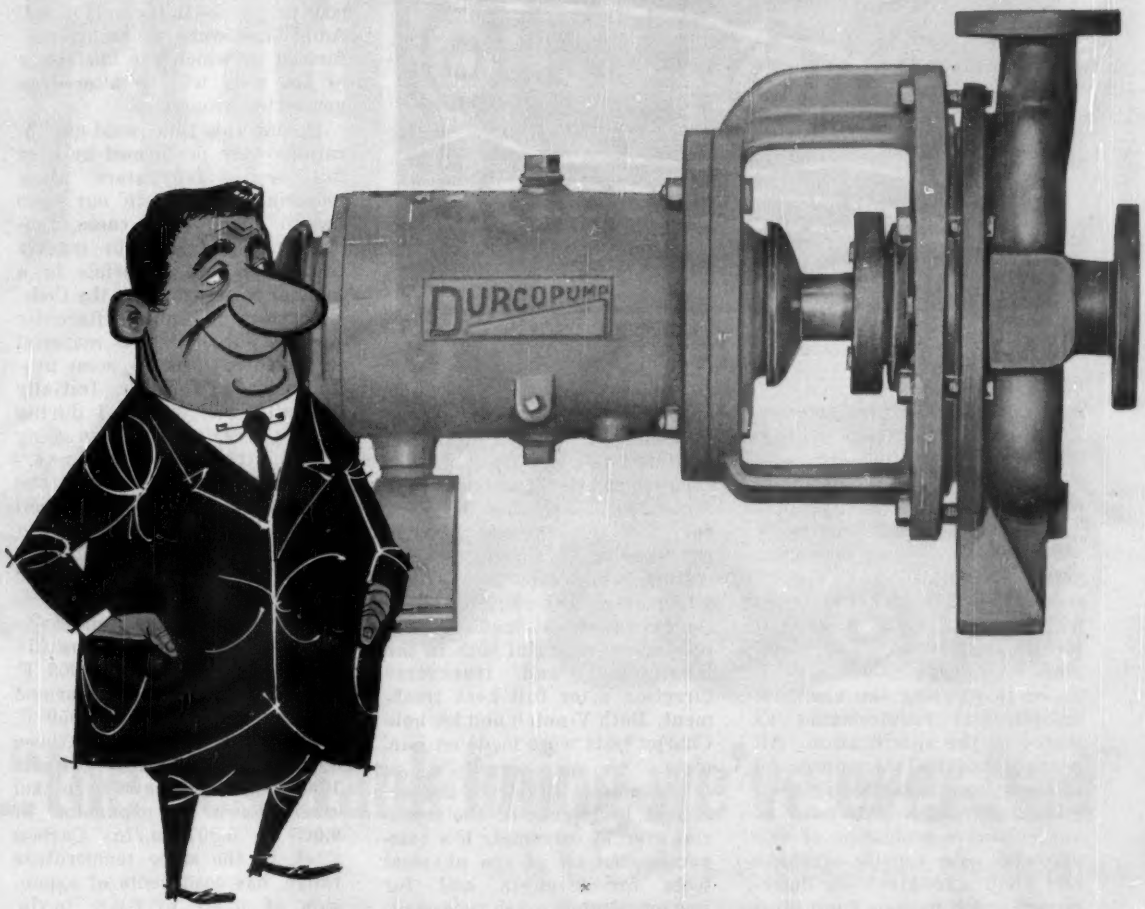
ASTM tensile requirements call for a minimum tensile strength of 90,000 psi., a minimum yield strength (0.2% offset) of 60,000 psi., and a minimum elongation in 2 in. of 22% (all at room temperature).

An unusual feature of the A-353 specification: double normalizing heat treatment must be used. The plate material must be normalized from approximately 1,650 F. and reheated to 1,450 F. Also, the ASME Code requires stress relieving of the finished weld-

*Meet your author on p. 177.

THE PUMP THAT'S CLOSEST TO MY HEART

AND MORE DEPENDABLE!



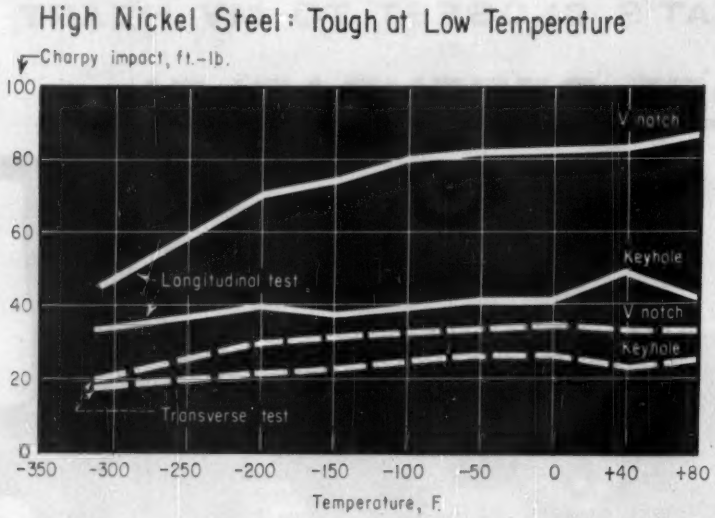
Series H Durcopumps are designed and built to give maximum service at minimum overall cost when handling severely corrosive solutions. These pumps are built with capacities from ½ to 3500 gpm, and with heads to 345′ They are available in twelve standard corrosion resisting alloys. When you are looking for a better chemical pump, look to Durco.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC.

DAYTON, OHIO

Branch Offices: Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Philadelphia, and Pittsburgh.



ment at a temperature between 1,025 and 1,085 F. These requirements are based on extensive data which show that optimum low-temperature impact properties result from this treatment.

The table below shows an actual chemical analysis of some of the 9% nickel material which we produced, with typical tensile properties in 1/2 in. plate. No difficulty was experienced in meeting the chemical or physical requirements as stated in the specification. All heats of material were produced in basic open hearth furnaces.

► **High Strength**—As part of our extensive evaluation of this material, the tensile strength and yield strength were determined under various conditions of heat treatment. Tests were made in the as-rolled condition, on material normalized from 1,650 and 1,450, and on material with the double normalizing treatment and an additional stress relief at 1,050 F. The tensile and yield strengths are quite high in the as-rolled plate and are close together. The double normalizing treatment increases the tensile strength slightly and widens the spread between tensile and yield strength. The stress relieved material shows slightly lower physical properties although they are still at a high level. Elongation in 2 in. under all heat treatments is approximately the same, although a marked improvement in reduction of area is produced by the double normalizing, stress relieving treatment.

► **Tough at Low Temperatures**—Since this steel was designed for low temperature service, the results of Charpy impact testing were considered most important. The curves show typical values obtained from the production material both in the longitudinal and transverse direction after full heat treatment. Both V-notch and keyhole Charpy tests were made on ½-in. plate.

These tests illustrate the excellent toughness of the material even at extremely low temperatures. All of the physical tests for strength and for impact toughness are representative of a great number of tests made on this material.

Additional evaluations were conducted to confirm the weldability of 9% nickel with established techniques and electrodes.

It has previously been reported that excellent welding results had been obtained using 25-20 stainless steel electrodes or a high chromium electrode (Inco rod "A") with manual technique. Evaluations using manual electrodes as well as inert gas-shielded consumable electrode techniques were conducted at Lukens and at other companies. In all cases, satisfactory impact properties were developed in the weld metal, the base metal, and the heat affected zone. Tensile and yield tests at satisfactory levels were obtained as well as good bends.

Some work was also performed using submerged-arc welding techniques. Initial results show poor properties in the weld metal. Additional work is being performed in which the chemistry of the weld will be altered to get better properties.

During this time, weld qualifications were performed by over five vessel fabricators using material produced in our open hearth heats. In all cases, fabricators were able to qualify procedures and materials in a manner satisfactory to the Code.

► **Forming Trouble**—Recently Lukens supplied this material in the form of heads, some produced by hot forming. Initially difficulty was observed during the hot pressing operation using dies originally designed for carbon steel material. Since the difficulty appeared to be associated with the coefficient of expansion of the material, dilatometer tests were performed to establish expansion characteristics. We were unable to obtain data from the literature at temperatures above 1,000 F. Since hot pressing is performed at temperatures up to 1,650 F, it was necessary to obtain these data experimentally. From 1,000-1,650 F. the 9% nickel steel shows an expansion of 0.005 to 0.007 in./in. Carbon steel, in the same temperature range, has coefficients of expansion of 0.007 to 0.009 in./in. Using this information, it was found that a modification of the time-temperature cycle during the hot pressing operation made it possible to produce satisfactory heads on existing equipment.

It is our feeling that these experiments and evaluations confirm the suitability of A-353,

Typical Properties: 8% Ni Steel

C	0.09%
Mn	0.50
Ni	8.99
P	0.012
S	0.025
Si	0.27
Tensile st., psi	100,400
Yield st., psi	73,600
Elongation in 2 in. (½ in. plate),%	25

PERMOBOND

...“the best tank lining we’ve ever had”

SAYS THIS LARGE ACID-CARRYING FLEET OWNER

One of the largest fleets of acid-carrying trucks in the East is P. B. Mutrie Motor Trans., Inc., owner of about 50 acid tankers. The truck above is one of their newest, and is the largest *rubber-lined* tank truck in New England, and one of the largest in the country. Like the other dozens of Mutrie’s tanks, this one is lined with PERMOBOND,® the rubber lining that is resistant to corrosion, and that prevents iron rust from contaminating the chemical in the tank. This truck also carries a U. S. Rubber Acid Discharge Hose, engineered to fit particular corrosion conditions.

Any container of corrosive acids, no matter how complex its shape, can be lined with PERMOBOND—whether it is original equipment or existing equipment—whether it’s over-the-road tank trucks or railroad tank cars.

So, for any rubber lining requirement, contact tank lining experts at U. S. Rubber, Mechanical Goods Division, Rockefeller Center, New York 20, N. Y.

In Canada, Dominion Rubber Co. Ltd.

Mechanical Goods Division

United States Rubber

9% nickel material for fabrication and service in low-temperature equipment. Additional heats have been scheduled by Lukens and other producers. We anticipate that the demand for 9% nickel will increase rapidly in the future.

REFERENCES

1. Armstrong, T. N. and A. J. Miller of Inco, paper on "Notched Bar Impact Properties of Some Nickel Steels After One Year Exposure," delivered at ASME National Conference on Petroleum Mech. Eng., Tulsa, Okla., Oct. 7-9, 1946.
2. Armstrong, T. N. and A. J. Miller paper on properties of low-carbon 8½% nickel steel delivered at National Conference on Petroleum Mech. Eng., Houston, Tex., Oct. 5-8, 1947.
3. Armstrong, T. N. paper on "Impact Tests of Pressure Vessels at -320F." delivered at Conference on Petroleum Mech. Eng., Amarillo, Tex., Oct. 3-6, 1948.

A Fresh Approach To Corrosion Problems

One day in the future it may be possible to design a corrosion resistant system as we design distillation towers. This is the fond hope of all engineers who must now empirically choose the "right" material of construction.

A step away from the strict empirical approach was recently taken by Carpenter Steel with the opening of their new corrosion laboratory in Reading, Pa. There is good evidence in the new lab that Carpenter is looking for the "how and why" answers to corrosion—an area in great need of some good answers.

For instance the lab is equipped with some unique heat transfer corrosion test equipment. It simulates actual conditions in a heat exchanger. The sample, heated electrically, is held at a different temperature from the corroding solution, and heat transfers through the metal into the corrodent. This gives much more accurate results than simply immersing a metal sample in a boiling solution.

Another new piece of equipment used in the lab is the Corrosometer—a device which can pick up microinches of corrosion —important in detecting fine differences between alloys. Actually the gadget measures change in cross section, as the corrodent goes to work on the sample, in terms of electrical resistance. Results are available in 24 to 48 hr., compared to 2 to 6 weeks for standard immersion tests (see *Chem. Eng.*, Jan. 1957, p. 156).

Is Wood on The Way Out?

Light-weight inorganic planks and panels, products of the laboratory rather than the forest, may soon supplement the nation's lumber supply, according to scientists at Battelle Memorial Institute, Columbus, Ohio. They have developed a portland cement-based material that has many of the desirable properties of wood. The new material is now being produced on a pilot-plant scale for field study. Costs look as if they will be competitive with a number of building woods.

The wood substitute is produced by casting a mixture of portland cement and other inorganic materials in molds and steam-curing it. Yet unnamed, the new material, developed for Wells Manufacturing Co. of South Bend, Ind., has about the same density as wood, weighing only 35 lb./cu. ft. Like wood, it can be sawed, nailed, or glued. Conventional wood-working tools can be used to work this material, which possesses good flexibility. Laboratory-produced "timber" is fireproof, rot-proof, and does not expand in humid atmospheres. While having only about half the strength of hard woods, the material is "strong enough for many jobs now done with wood," according to M. Jack Snyder in charge of the Battelle group.

New Coating Processes Deposit Molybdenum

New chemical processes for depositing molybdenum on other metals have opened the door to wider utilization of its favorable properties, according to H. W. Schultze, manager of new chemical and catalyst development for Climax Molybdenum Co. Div., American Metal Climax, Inc.

Despite recent advances in producing and fabricating molybdenum metal, there are many applications where it is economically or technically impractical (fabricating and forming difficulties) to use the solid metal. Vapor-deposited coatings, however, make it possible to enjoy the advantages of molybdenum's corrosion resistance, wear resistance, and high strength at elevated temperatures, and at the same time, benefit from the desirable properties of the materials on which it is applied.

An important new coating process involves the use of molybdenum pentachloride for vapor deposition of molybdenum. With hydrogen as the reducing agent, the reduction byproduct is hydrogen chloride, which can be easily removed by a suitable pumping system without contaminating the reduced metal. With reduction temperatures around 850 C. the metal film is completely dense, with a well-developed grain structure.

The process for producing vapor-deposited molybdenum with molybdenum pentachloride is run at reduced pressures—in the order of 20 mm. Hg. Since molybdenum pentachloride melts at 194 C. and boils at 268 C., vapors can be readily obtained.

Another new method of coating with molybdenum involves thermal decomposition of molybdenum hexacarbonyl, another vapor-phase process. This process produces molybdenum coatings of a quality approaching the pentachloride. Carbonyl deposition, although requiring careful engineering and control, can be modified to give coatings not only of molybdenum, but also molybdenum carbide or combinations of the two.

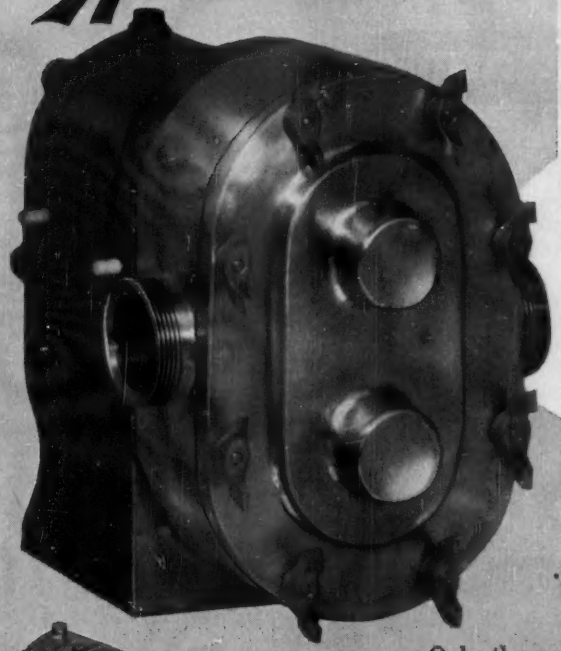
The carbonyl process has the advantage of operating at lower temperatures than hydrogen reduction of pentachloride. At temperatures of 350 C. molybdenum deposits; at higher temperatures the carbide forms.

An enclosed system is necessary. The piece to be plated is cleaned and heated. Molybdenum hexacarbonyl vapors transported by carrier gases, pass over the heated piece where they decompose and deposit the metal. Byproduct is carbon monoxide.

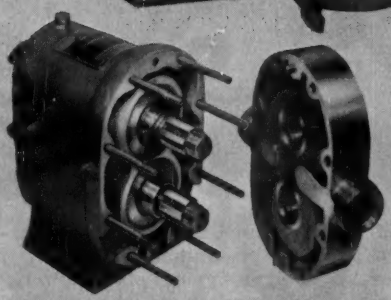
Waukesha

CORROSION RESISTANT P. D.* PUMPS

the Constant Heart of Your Product Flow



*Positive Displacement



2 O-rings, one under the replaceable, stainless steel shaft sleeve, the other in the pump head provide a positive seal against leakage.

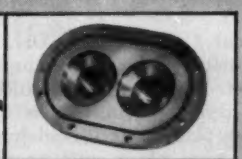
Only the positive displacement pump principle gives you a smooth, constant capacity with no variation.† Your volumetric requirements are satisfied with high precision.

Only positive displacement eliminates pulsation, aeration, churning, turbulence or agitation of your product. The new Twin Blade counter-balanced impellers in WAUKESHA PUMPS create a *gentle* flow at all pump speeds.

A WAUKESHA PUMP is literally the heart of your product line, steady, trouble-free, dependable, month in and month out with a very minimum of maintenance.

New twin blade counter-balanced impellers assure smooth product flow, handle all fluids or products with small or large discrete particles.

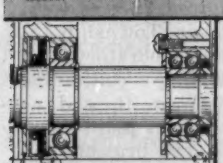
Slot and pin for stainless steel sleeve on shaft keep shaft and sleeve rotating together, save shaft wear.



Re-usable rubber pump head gasket provides a complete seal at all vacuums and head pressures. Eliminates the use of fussy, temporary paper gaskets.

†*Variations in delivered capacity in the WAUKESHA PUMP are caused only by differences in suction pressures, discharge pressures or power lags. All these are factors outside of the pump itself.*

Have you the new Waukesha Catalog in your files? Send for it today. Please state product you pump, temperatures when pumping, suction and discharge pressures.



Short distance between shaft bearings and sturdy shaft permits pump to operate against head pressures up to 150 P.S.I.

New side mounting design (optional) puts inlet and outlet ports in vertical position. Saves fittings. Excellent for heavy, viscous fluids.

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MIX MILL BLEND EMULSIFY
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The Abbé Dispersall Mixer disperses, mills and blends (as well as emulsifies) in ONE operation. Solid ingredients are *completely* dispersed in a fraction of the time required by conventional mixers. Eliminates pre-milling and pre-mixing.

The Abbé Dispersall Mixer gives you speed and power, plus the tremendous advantage of easy cleaning in changing from one product to another. Tooth pastes, ointments, paints, colors and pharmaceuticals, etc., are mixed and dispersed better and faster in the Abbé Dispersall Mixer in a ONE-stage operation. Write for Catalog 78.

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PEOPLE . . .

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES

This Month's Top Projects:

Linde Co. plans to erect a 300-ton/day liquid oxygen-nitrogen plant at Pittsburg, Calif., to meet expanding needs of missile industries. First units will start up in June 1959, with balance of capacity coming on stream a few months later.

El Paso Natural Gas Co. is starting construction on a $5-6-million natural gasoline extraction plant at Opal, Wyo. Firm expects daily recovery of 83,000 gal. butane, 122,000 gal. propane and 62,000 gal. gasoline. Plant will feature indoor construction—a gas processing "first" prompted by Wyoming's severe weather.

Lummus Co. has signed to engineer and build Air Reduction Co.'s $12-million polyvinyl alcohol resin plant at Calvert City, Ky. When completed in early 1960, plant will produce 20 million lb./yr. resin.

Standard Oil of California announces it has awarded contract for construction of a 40,000-bbl./day catalytic cracker at its Richmond, Calif., refinery to Fluor Corp. Contract negotiations for other units in refinery expansion program are still pending. Unofficial estimates place cost of expansion at upwards of $33 million.

National Cylinder Gas Div. of Chemetron Corp. has begun construction on a $3-million liquid oxygen, nitrogen and argon plant near Philadelphia, Pa. New plant will provide direct pipeline supply of oxygen to Alan Wood Steel Co.'s abuilding H-iron plant at Conshohocken, Pa.

Miles Laboratories is planning a $4.5-million project to expand its citric acid production facilities at Elkhart, Ind., with construction slated to start in late summer or early fall. Output will be considerably greater than firm's internal needs enabling Miles to become a large citric acid marketer for the first time. Plant will use company-developed submerged fermentation process.

Humble Oil is reportedly studying preliminary plans for a polypropylene plant. Probable location would be at Baytown, Tex., headquarters for many of firm's operations.

Sarco Mfg. Co. is expanding manufacturing facilities for its Thermo-Dynamic steam traps by 50% at Bethlehem, Pa., plant site. TD steam traps automatically drain condensate and air from steam systems ranging from 10 to 600 psi.

Air Reduction Chemical Co. has two projects on tap for its newly acquired 32-acre tract in Piscataway Township, N. J.: A new laboratory and office building containing about 10,000 sq. ft. and an "extensive" pilot plant facility. Cost of two projects will total over $1 million.

J. T. Baker Chemical Co. announces that it has made a "substantial increase" in

PHOTOGRAPHED UNDERWATER AT FLORIDA'S SILVER SPRINGS

Underwater is home for this motor!

New Louis Allis Immersible motor is built to operate in water, sewage, or liquid chemicals

The Immersible motor can be adapted to operate in any kind of liquid — fresh or salt water, sewage, chemicals, or abrasive industrial cutting oils. It's the ideal means to provide power in a vat or sump — at the bottom of a pool, lake, or ocean!

No matter how deep your setting, the Immersible motor provides close-coupled power — saves you the need for expensive jack-shafting, intermediate bearing supports between pump and a surface-mounted motor, and mounting structures.

The motor is oil-filled and sealed at the factory. Diaphragm breathers equalize internal and external pressure — eliminate pressure at the shaft seal and prevent leakage. All joints are sealed to keep water and dirt out. Vinyl-coated housing and stainless or suitably plated exposed parts resist corrosion. Mating surfaces of the housing and flange are precisely machined to provide accurate alignment of the pump impeller and casing.

The Immersible, as shipped, is ready for horizontal or vertical mounting on pumps, agitators, mixers, or special equipment. Sizes range from ¾ to 40 hp. For additional information contact your local Louis Allis District Office, or write for Bulletin 2300, The Louis Allis Co., 447 E. Stewart Street, Milwaukee 1, Wisconsin. But do it today!

SM-109

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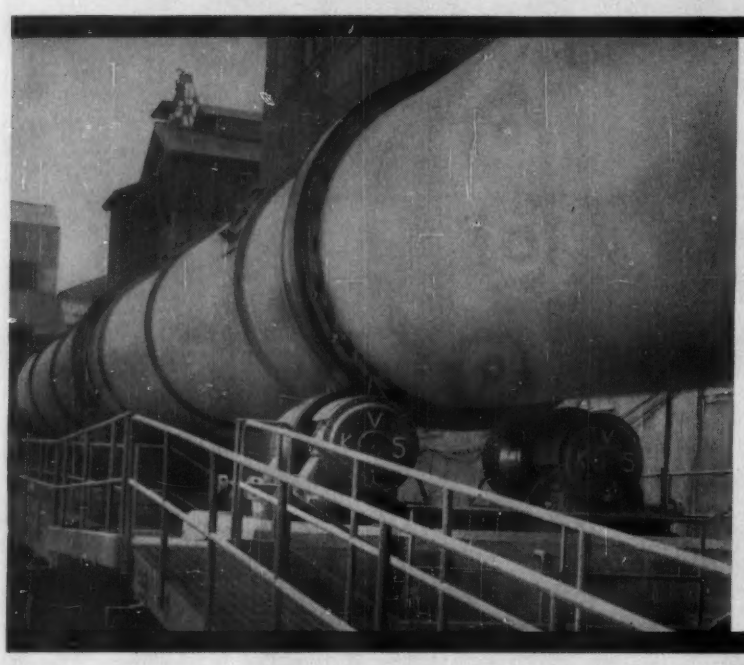
MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

KENNEDY ROTARY KILNS



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Nodulizing and Agglomerating

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This 11 ft. diameter by 375 ft. KENNEDY Rotary Kiln processes 2,960 barrels of cement per day.

KENNEDY Kilns have a reputation for steady, high production—for economical operation—for low maintenance—and for long life. You can expect higher profits with a KENNEDY Kiln.

Compare these KENNEDY features:

- Self-aligning bearing pedestals
- Stationary firing hood with swinging entrance ports for quick, easy internal access
- Truly effective air seals
- Drive gear mountings avoid thermal stresses
- Built in any length or diameter
- Designed to give economical, efficient operation over long periods

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Jaw Crushers
Roll Crushers
Impact Breakers
Hammer Mills
Ball, Rod & Tube Mills
Rotary Kilns
Dryers
Preheaters & Coolers
Complete Cement and Lime Plants
Pneumatic Conveying Pumps
Air Float Conveyors
Complete Pneumatic Conveying Systems
Pulverized Coal-Gas-Oil Firing Systems

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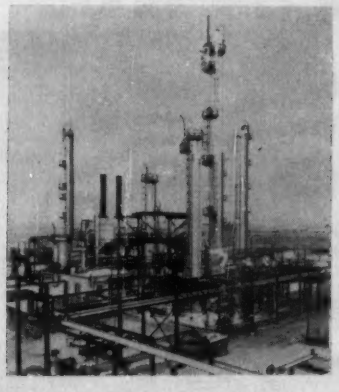
production capacity of ammonium thiocyanate at Phillipsburg, N. J.



Richfield Oil Corp. took its first major step into petrochemical field when its $6.5-million benzene-toluene unit was put into operation at firm's Wilmington, Calif., refinery. Unit will produce 18 million gal./yr. nitration-grade benzene, nearly doubling West Coast output.

Dayton Rubber Co. has negotiated an $11.4-million loan and will use a portion of capital to equip a new mechanical rubber goods plant to be built at Springfield, Mo. Balance will be used to retire long-term notes and to increase working capital.

General Electric is building a million-dollar, 104,000-sq.-ft. plant for its computer department at Phoenix, Ariz. Plant is expected to be ready for occupancy in December.

Royal Dutch Shell has awarded contract to Matthew Hall & Co., London, Eng., for a 50,000-ton/yr. synthetic rubber plant at its Pernis refinery in the Netherlands. Unit, scheduled for operation in 1960, will be Holland's first synthetic rubber installation.

Air Force will build research and development facilities in the Denver, Colo., area for developing nuclear power reactors for manned aircraft. Initial cost of project will be $22.5 million with eventual

THE ALL PLASTIC VALVE THAT
DEFIES CORROSION

VALCOR's all plastic, corrosion-resistant solenoid valve, SV-5100 series, is the only solenoid valve that has no metal contact with the fluid—ever. Specifically designed to handle most of the corrosive media so widely used in industry, VALCOR's new, all plastic solenoid valve will, in many cases, outlast stainless steel valves 100 to 1.

If you have a corrosive media problem, from sulphuric acid solutions to citrus juices, try this new VALCOR valve on your toughest application. Prove for yourself how this new valve defies corrosion. List prices start at $8.50.

IMPORTANT: Hundreds of other valve variations, in design and pressure ratings, are inherent in this new SV-5100 series. By incorporating some of the very newest engineering and chemical formulas, we can offer valve variations designed to meet almost any corrosion problem you might be faced with.

Write today for new catalog sheet. For specific information, please send us pertinent application details.

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SOLENOID VALVES

The finest general purpose temperature regulator in the industry. For the first time, you can get premium quality "extras" at no added cost. This new self-powered regulator is trouble-free, powerful and sensitive. Installation is easy and inexpensive. Large Sylphon® Bellows provides perfect stroke action for valves up to 4". Handles pressures up to 250 psi. Designed for extra-long life.

5 new extras at no extra cost:

1. New Teflon Chevron valve stem packing—no sticking, no leaking, no lubrication . . . ever!
2. New Monel Valve Stem—super-finished to prevent sticking!
3. New "Quick-Detach" stem fitting—valve removable without disturbing adjustments!
4. New Design incorporates "MA" valve—for "dead-end" service!
5. New overrun assembly—prevents regulator damage from overheating!

WRITE FOR BULLETIN D-CN

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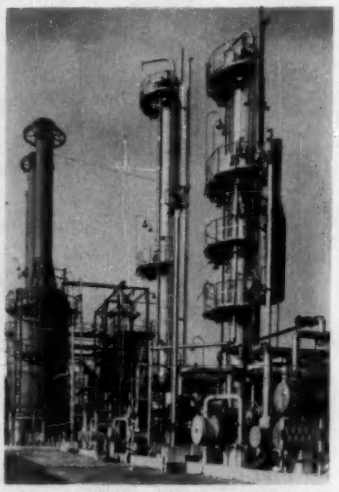
cost running to $65 million; construction will start late this summer with completion scheduled within three years.



M. W. Kellogg-designed catalytic reformer with desulfurization facilities has been placed on stream by Raffinerie Belge de Petroles, Antwerp, Belgium. Unit reforms 2,500-bbl./day of Iraq heavy straight-run naphtha into 88 F-1 clear octane reformate.

Yuba Consolidated Industries has acquired its eighth firm in the past year and a half—Judson Pacific-Murphy Corp., Emeryville, Calif. Acquisition of Judson Pacific-Murphy for $3.5 million cash strengthens Yuba's position in steel fabrication field.

National Steel Corp.'s Weirton Steel Div. is acquiring Crown Cork & Seal Co.'s cold reducing mill located at Crown's Baltimore, Md., plant. Equipment will be utilized in Weirton's steel operations.

Bowen Engineering, North Branch, N. J., has purchased the business and assets of Instant Drying Corp. of New

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This huge Lectrodryer *must* stay on-stream until turn-around time. It dries recycle gas in the platforming operation, where moisture must not get through to foul the catalyst.

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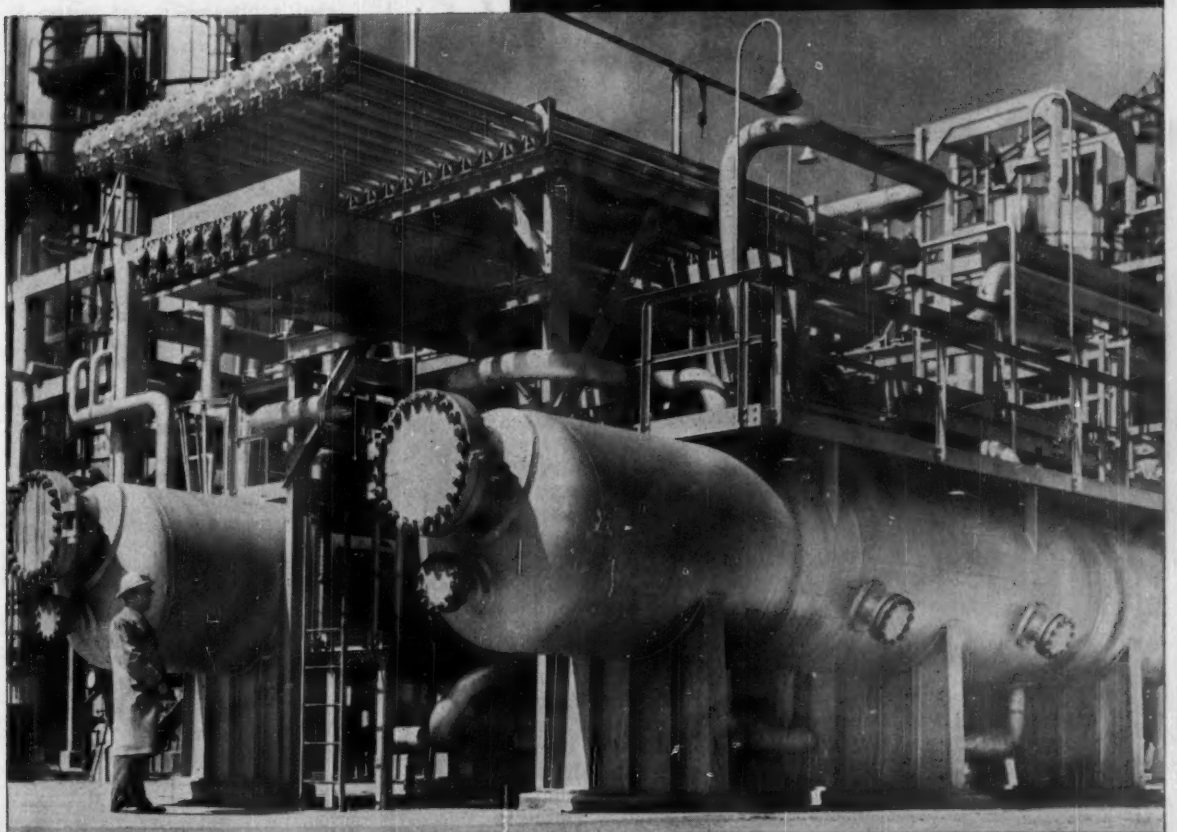
Whether your drying needs are for thousands of feet per hour or only a few—for drying air, gas or organic liquid—there is a Lectrodryer to do the job. Let our engineers help you select the *right* equipment for your particular drying needs. Pittsburgh Lectrodryer Division, McGraw-Edison Company, 303 32nd St., Pittsburgh 30, Pennsylvania.



Lectrodryer builds them BIG as well as small. This Type H unit is working at Sinclair Refining Company, Marcus Hook, Pennsylvania.

Leading industries look to

Lectrodryer® McGRAW EDISON

World's First and Foremost Manufacturer of Commercial and Industrial Adsorbent Dryers

The very latest in

Package Type Plants

Producing

OXYGEN and NITROGEN

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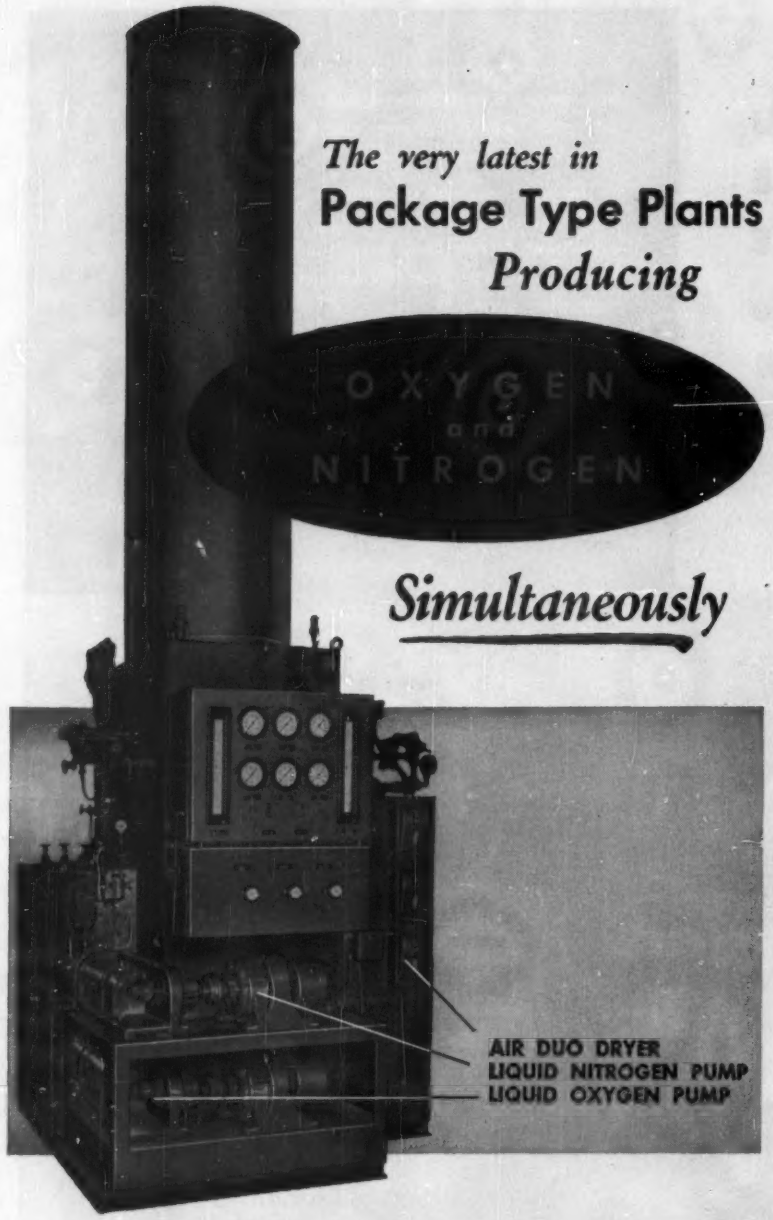

With the introduction of our latest, improved design Package Type Generating Plants, production of high purity Oxygen and Nitrogen simultaneously *increases* production 60% over the production of Oxygen alone, *plus* a corresponding reduction in the *cost* of manufacture. Due to its compact design, a minimum of floor space is required and streamlined panel assembly insures instant visibility of all control gauges. Stock sizes from 1500 to 10,000 cu. ft. per hour. Larger and smaller sizes available. 99.99% Argon available on large size plants.

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ACETYLENE - OXYGEN - NITROGEN - ARGON

O'FALLON 7, ILLINOIS

FIRMS . . .

York, N. Y., oldest firm in spray drying equipment field.

American-Saint Gobain Corp. has become successor company in merger of American Window Glass Co. and Blue Ridge Glass Corp. Blue Ridge Glass will now operate as a division of American-Saint Gobain.

Fluor Corp. has purchased name, patents, trademarks and other assets related to wood fabrication business of Summerbell Roof Structures of Los Angeles. Acquisition, for an undisclosed sum, did not include any of Summerbell's physical assets or real estate.

NEW COMPANIES

Hampshire Chemical Corp., with headquarters in Nashua, N. H., is a new company researching, producing and marketing a group of specialty chemicals including nickel and copper stripping compounds, bottle washing compound additives, high-kill slimicides and synthetic amino acids with wide agricultural applications.

Utah Salt Co. is planning to produce salt for Pacific Northwest caustic-chlorine industry. Firm has leased salt ponds near Wendover, Utah, owned by Bonneville, Ltd., a solar evaporation potash producer.

Jefferson Lake Petrochemicals of Canada, Ltd., is being set up by Jefferson Lake Sulfur Co. to take over its Canadian inventory and assets, mostly in British Columbia and Alberta. Initial activities of new firm will be production of sulfuric acid from H_2S from an existing plant and development of Alberta sour gas sources for production of sulfur, pipeline gas, LPG and natural gasoline.

CALENDAR

American Farm Research Conference, Purdue University.
July 16-18 Lafayette, Ind.

International High Polymer Conference, University of Nottingham.
July 21-24 Nottingham, England

Gordon Research Conference, Statistics in Chemistry and Chemical Engineering, New Hampton School.
July 21-25 New Hampton, N. H.

Gordon Research Conference, Chemistry at Interfaces, Kimball Union Academy.
July 21-25 Meriden, H. H.

Technical Association of the Pulp and Paper Industry, 13th Engineering Conference, Multnomah Hotel.
July 28-Aug. 1 Portland, Ore.

Gordon Research Conference, Instrumenttation, Colby Junior College.
July 28 Aug 1. New London, N. H.

Gordon Research Conference, High-Pressure Research, Kimball Union Academy.
July 28-Aug. 1 Meriden, N. H.

Gordon Research Conference, Elastomers, Colby Junior College.
Aug. 4-8 New London, N. H.

Gordon Research Conference, Radiation Chemistry, New Hampton School.
Aug. 4-8 New Hampton, N. H.

Western Packaging and Materials Handling Exposition, San Francisco Civic Auditorium.
Aug. 11-13 San Francisco, Calif.

Gordon Research Conference, Chemistry and Physics of Metals, Kimball Union Academy.
Aug. 11-15 Meriden, N. H.

American Institute of Chemical Engineers-American Society of Mechanical Engineers, Second National Heat-Transfer Conference, Edgewater Beach Hotel.
Aug. 18-21 Evanston, Ill.

Gordon Research Conference, Inorganic Chemistry, New Hampton School.
Aug. 18-22 New Hampton, N. H.

Gordon Research Conference, Chemistry of Adhesives, New Hampton School.
Aug. 25-29 New Hampton, N. H.

British Association for the Advancement of Science, 120th annual meeting.
Aug. 27-Sept. 3 Glasgow, Scotland

Second International Conference on the Peaceful Uses of Atomic Energy, sponsored by United Nations.
Sept. 1-13 Geneva, Switzerland

American Society of Mechanical Engineers, International Conference on Air Pollution, Hotel Statler.
Sept. 4-5 New York, N. Y.

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It'll pay you to climb on the band wagon for Wyandotte *Flo-chilled** Anhydrous Caustic Soda. It's K.O.'d that old bugaboo of caking and lumping in hot, humid weather—because it's *Flo-chilled* to flow free and easy in your automatic machinery *any* time of the year. Order a supply from your Wyandotte representative or distributor today . . . you'll find it's the same price as ordinary caustic! *TRADEMARK

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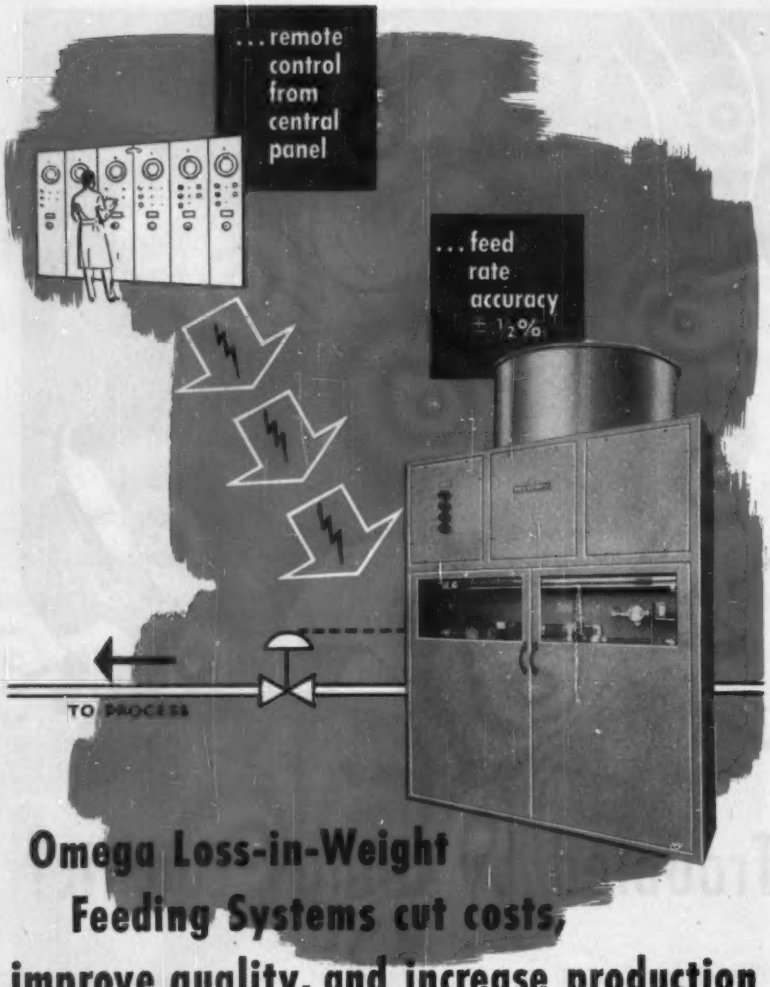


Omega Loss-in-Weight Feeding Systems cut costs, improve quality, and increase production

The new Rohm & Haas plant at Deer Park, Texas, has a critical continuous process which demands *accurate feeding* of all components for its successful operation. After a survey of available continuous feeding equipment, their engineering department selected Omega Loss-in-Weight Feeding Systems to control the feed of the key liquid component into the process. Here's why they made this selection:

Accuracy—The Omega Loss-in-Weight Feeding Systems provide guaranteed accuracy of ±½% by weight of set feed rate.

Remote Control—from central panel, complete with printed record.

Control-loop—with feedback and memory features.

Explosion-proof — a fully protected system.

The Omega Feeding Systems have amply proven themselves in over a year's operation. Benefits are:
—Better quality control
—Savings in valuable process materials
—Increased production
—Safer working conditions

Write for Bulletin 32-R2 describing Omega Continuous Loss-in-Weight Feeding Systems for liquids and dry materials. **Omega Machine Company, Process Application Department, 369 Harris Ave., Providence 1, R. I.**

OMEGA MACHINE CO.
DIVISION OF
B-I-F INDUSTRIES
METERS FEEDERS CONTROLS

PEOPLE . . .

TECHNICAL

Dishes in a Cafeteria

MANAGEMENT FOR ENGINEERS. By Roger C. Heimer. McGraw-Hill Book Co., New York. 453 pages. $6.75.

Reviewed by Arthur Lesser, Jr., Department of Industrial Engineering, Stevens Institute of Technology.

For the person who wants to obtain background material in selected areas of management, this book might be a good starting place.

However, as to why certain areas were selected and others (such as production scheduling, safety and personnel practices) were omitted, it's left up to the reader to speculate or to rely on the expertness of the author.

This comment highlights the point that the book has no particular focus. It wanders over the field of management, choosing first this topic, then that, much as a person would select dishes in a cafeteria.

The book is divided into two main categories.

Approximately the first three-quarters (12 chapters) is devoted to the substance of what managers are concerned with day in and day out and some of the techniques they employ in doing these things. (The first chapter deals with the professional engineer.) Such topics as Depreciation, Insurance, Inventory, Standards, Budgets and Money Flow in the Business Enterprise are a fair sample of what is covered.

The last quarter of the book (4 chapters) deals with concepts of management, namely Organization in Industry, Communication and Coordination, Management Decisions and Industry Decision-Making Situations.

If there is a relationship among the topics in the first thirteen chapters, the author does not make clear what the relationship is.

For instance the chapter on Insurance follows Power and

BOOKSHELF

J. B. BACON

Light which follows Interest and Time. Chapter 8 on Insurance might well have carried home the notion that one prime function of management is risk bearing in an uncertain world and that some risks can be insured against, but others cannot be. (The author deals with some aspects of uncertainty in Chapter 16 on decision making.)

A brief examination of the problem of uninsurable risks from the managerial viewpoint, which may shed some light on why some projects dear to engineers are rejected by management, would be interesting. However, the book does not explore, nor does it furnish much in the way of analysis or evaluation.

Like practically all books on management, it follows the usual approaches of description (telling about) and prescription (the "should do's" in a cookbook sense). One expects more from a book on management for engineers.

In general the last four chapters are better coordinated and leave the reader with something to think about and some small understanding of the process of management and its difficulties.

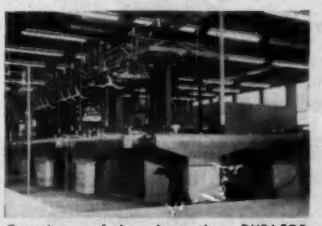
One of the most puzzling aspects of the book is the explicit lack of recognition of the fact that the presence of people is the sharply differentiating characteristic of management from engineering. The problem of measuring the activities or attributes of people is quite different from measuring things. The setting of standards (specifications) for things is a different matter from the setting of standards of performance for people, where acceptance of the standard is vital in relationship to performance, and where manipulation of the standard for personal ends is commonplace.

In conclusion, the reviewer does not feel that this book makes much of a contribution to the literatures. It breaks no new ground and does not improve on the usual treatment of the old.

another corrosive fumes ventilating problem

Duracor Ventilation System exhausts 250,000 C.F.M. of corrosive fumes from large electronic equipment plant.

Strong, lightweight DURACOR ducts over 5 feet in diameter require minimum support.



Corrosion-proof throughout, these DURACOR "drops" need no exterior protection from spillage.

Weather and corrosion resistance are provided by DURACOR "T" sections on roof.

PROBLEM: This ventilating system had to withstand sulphuric, nitric, chromic, phosphoric acid and cyanide fumes emitted from the plant's plating and anodizing operation.

SOLUTION: Working from customer specifications, Ceilcote engineers built the entire ventilating system shown here completely from DURACOR.

INSTALLATION: Experienced Ceilcote supervisors and crews handled the complete installation under one contract. Materials and workmanship are fully guaranteed.

WHAT'S YOUR PROBLEM? . . . DURACOR resists any corrosive gas, fume or liquid . . . can be fabricated to virtually any shape. Write today and tell us about your requirements.

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NEW-

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Details of heavy-duty compressors, multi-cylinder compressors, booster systems, condensers, coolers, coils, controls, valves and auxiliaries are fully explained.

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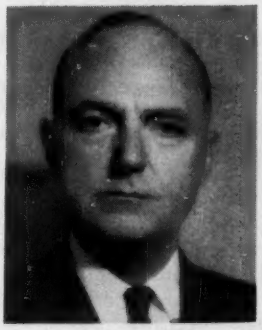
PEOPLE . . .

MEET YOUR



Richard P. Windisch

CHEMICAL INDUSTRY IN PLASTICS: ON TOP TO STAY PAGE 98.

"Background music," as the author himself labels it, for the career of Richard P. Windisch sounds like this:

He graduated from MIT in 1921 with a B.S. in chemical engineering administration and began his chemical career "inking tickers on Wall Street instead of washing beakers in Wilmington."

In 1930, he "returned to MIT (in spirit) and started again as a freshman with the realization that chemistry was to be the coming horse and one which teamed up very successfully with finance."

He has held every job possible in the security brokerage field from runner to managing partner of the New York Stock Exchange firm of W. E. Burnet & Co. After 27 years of partnership, he retired in 1946 to give more time to following chemical finance and economics through technical journals, society meetings and company visits.

"Now, still a scholar and student (called an analyst on Wall Street) he is, at heart, busy trying to find the best angle from which investors may take a shot at the galloping chemical industry." Principal hobby is translating "chemical jargon for financial experts who ducked their high school chemistry course, and advising pension funds, foundations, and investment funds how they may safely extract income and profits from acids and akalis."

AUTHORS...

M. A. GIBBONS

Joseph H. Proctor

LOW-COST CRYOGENIC STEEL GOES COMMERCIAL. PAGE 160.

Joseph H. Proctor is manager of marketing service of the Lukens Steel Co., Coatesville, Pa.

Before taking on his present post in 1956, he served as a design engineer in development engineering, technical service engineer in technical service and marketing service engineer in marketing service. He originally joined the firm in 1949.

Proctor graduated from Drexel Institute of Technology. He is a member of the ASME and the API.

John Happel

METHOD FINDS OPTIMUM TRAYS AND REFLUX RATIO. PAGE 144.

Last year, John Happel spent his sabbatical leave in Germany where he lectured on chemical engineering economics. Now, back at his regular post, he is chairman of NYU's department of chemical engineering.

RIGGS PORTABLE Log-linear, Gamma-Beta SURVEY METER

For New Freedoms in Survey Work— No Other Instrument Needed, Gamma/Beta Log Linear—Fast Response Time!

Model GB-1

Log-linear pressurized ionization chamber portable survey meter. Fast response time 0 to 1 mr/hr linear and two 3 decade ranges from .5 to 500 mr/hr, .5 to 500 R/hr. Mercury battery powered—300 hr. continuous operation, one year intermittent. Allows fast lab monitoring of low level Gamma-Beta radiation with the linear range and incorporates two higher log ranges for general survey work. Energy dependence—flat to within ±10% from 80 KV to 1.2 Mev.

Features include fast linear response time (one linear range 0-1 mr/hr), ability to measure high radiation with two logarithmic ranges (.5 mr/hr to 500 R/hr), Gamma-Beta sensitive, compact case design, eliminates need for two separate instruments. Model GB-2, same as Model GB-1, less the Linear Range with two Logarithmic Ranges, .5 to 500 mr/hr, 5 to 500 R/hr. Model GB-3, same as model GB-2, but with one logarithmic range, .5 to 500 mr/hr.

RIGGS Remote Area Gamma Monitor (GA-3 Series)

A completely self-contained, independent system with pressurized logarithmic response ionization chamber. Model GA-3B has Mercury battery supply for 4 months continuous operation. Model GA-3BA same as GA-3B but with AC power supply failsafe to DC. Model GA-3A available in AC power supply only.

General Features and Specifications

Any continuous combination 3-decade logarithmic ranges from .01 mr/hr to 100,000 R/hr.

Energy Dependence
Flat to within ±10% from 80 KV to 1.2 Mev.

Alarm Control System
Meter relays DC manual (optional). Alarm relay rated 115V AC 2 amps.

Recorder Output
10 mv operated directly from output of unit.

Electronic Calibration
Complete circuit check of all ranges both ends of scale.

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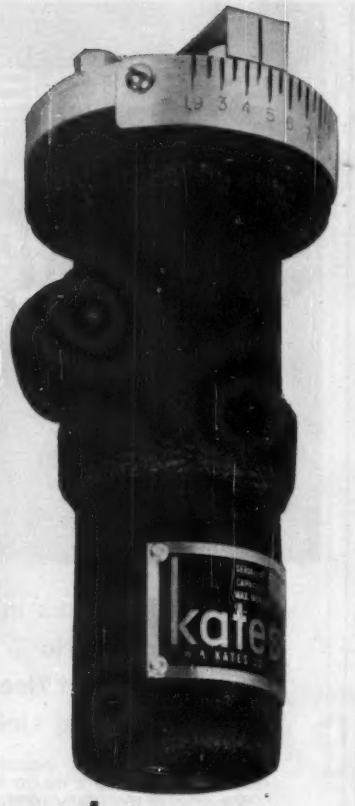

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Sounds incredible, doesn't it? No controller, no complex valve mechanism, no long approach piping, no electrical or pneumatic circuit—the functions of all these costly flow-system components are contained in this single compact unit, the Kates Flow Rate Regulator. This one unit *is* your system!

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Write for technical bulletin No. 561 for complete information on operation and application.

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Deerfield, Illinois

AUTHOR . . .

Professional career began with the Socony Mobil Oil Co. in 1930, where he was engaged in a number of technical posts involving the design and operation of petroleum refinery equipment and evaluation of motor fuels.

During the War, Happel was a member of the Petroleum Industry War Council. He joined the faculty at NYU in 1948 and became chairman of the department a year later.

Happel earned his bachelor and master of science degrees from MIT and a doctorate in Ch.E. from Brooklyn Poly.

Joseph G. Mason

BRAINSTORMING: NOW IT CAN WORK FOR YOU. PAGE 155.

As the first person to hold a State of Minnesota teaching certificate in the field of creative thinking, Joseph G. Mason is rather uniquely qualified to talk about brainstorming.

But, the degree isn't his only recommendation. He has been a member or executive of the creative departments of four major national advertising agencies; he has worked on more than 80 national advertising accounts.

Further, he has been closely associated with Alex Osborn, nationally known as the "father of brainstorming, who introduced this creative technique.

What's more, he has conducted three full-length courses in creative thinking for scientific and technical personnel at Minnesota Mining & Mfg. Co.

If you're not already convinced that he's the man to help you make brainstorming work for you, take a look at his articles on creative thinking in Nation's Business and in Advertising Age.

Using Salt Efficiently

by INTERNATIONAL SALT COMPANY, INC.

How to Measure Brine Strength on Different Hydrometer Scales

The most common method of measuring brine strength in industry is to use some type of hydrometer. Every hydrometer sinks into a liquid until it has displaced a weight of the liquid equal to its own weight. The scale divisions on a hydrometer are not usually of equal length, since the volume of displaced liquid increases as more of the stem is immersed.

Using a hydrometer is a relatively simple process—but reading the hydrometer scale is complicated by this fact: the scale may vary from plant to plant because hydrometers may be used to measure strength of other liquids, as well as salt brine. To help clear up any possible confusion, here are an explanation and a comparison of the five most common hydrometer scales used for measuring brine strength.

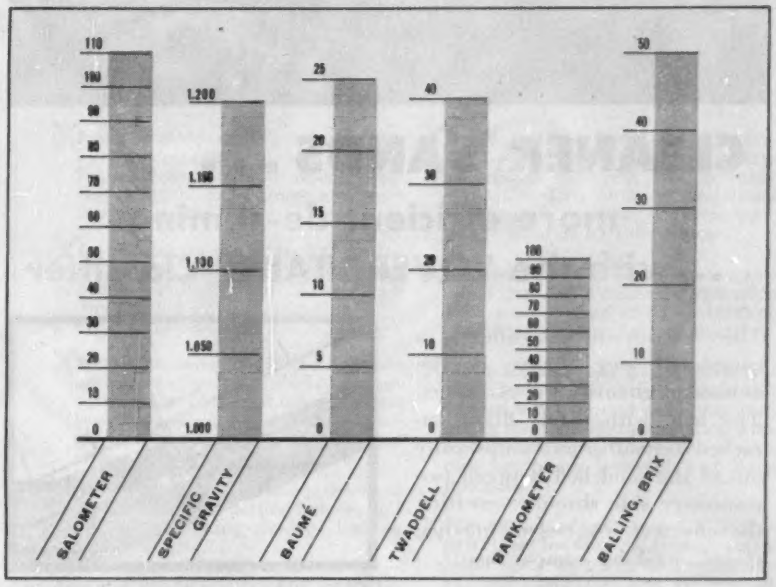
SALOMETER SCALE. This is by far the most common of all the hydrometer scales used for testing brines. The scale indicates directly the per cent saturation of the brine, reading 0° S. in pure water, and 100° S. in fully saturated brine. The salometer uses the values of Gerlach, meaning that 100%-saturated brine contains 26.395% salt by weight. Each salometer degree, then, represents 0.2639% salt.

The salometer reading expresses the per cent of saturation. Thus, a brine of 40° S. strength is 40% saturated, and contains 40% of 26.395%, or 10.558% salt by weight.

SPECIFIC GRAVITY SCALE. This reads the specific gravity of the brine *directly*. These hydrometers may be obtained with the entire length of scale covering a limited range of specific gravities, thus permitting great accuracy.

BAUMÉ SCALE. This scale was originally intended to have each degree equal a per cent of salt in the brine. But this is now only a rough approximation. The Baumé scale reads 0° Bé. in pure water, 24.6° Bé. in fully saturated brine. Also, a factor of "modulus" is needed to translate degrees Bé. to specific gravity, since the scale divisions are of equal length. This modulus has been standardized at 145, so that degrees Bé.=145–145/sp.gr.

TWADDELL SCALE. Named after its inventor, the Twaddell scale reads 0° Tw. in pure water, 40.8° Tw. in fully saturated brine. Each increase of 0.005 in specific gravity causes 1° increase on the Twaddell scale. Thus, the number on the right of the decimal point of the specific gravity, divided by 5, is the degrees Tw. For example: 1.140 sp.gr. is 140/5, or 28° Tw.



COMPARISON OF COMMON HYDROMETER SCALES

(Chart gives quick, visual relationships of readings on the salometer scale to readings on other scales.)

BARKOMETER SCALE. Used extensively for testing tanning liquors, the Barkometer scale reads 0° Bk. in distilled water, and 204° Bk. in fully saturated brine. Each increase of 0.001 in specific gravity causes 1° increase on the Barkometer scale. Thus, the number on the right of the decimal point of the specific gravity is the degree Bk. For example, 1.025 sp.gr. is 25° Bk.

The hydrometer scales described above are usually calibrated for brines at 60°F. temperature. When testing brines at other temperatures, it's necessary to make certain corrections...or to use a specially designed hydrometer. You can get a table showing proper temperature corrections, plus other data on measuring brine strength, from International Salt Company.

Using salt in its many industrial applications calls for technical knowledge and experience. International Salt Company has both—plus a continuing program of research and development in salt. These things can be put to work for you . . . in your plant . . . to help you get the most out of the salt or brine you use.

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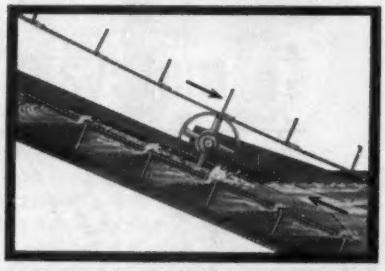
CLEANER SANDS . . .

more efficient de-sliming ...with the "OVERDRAIN" Classifier

The "Overdrain" Classifier is a completely new device in the field of mechanical wet classifiers. The belt, with lifting flights attached beneath, moves upwardly out of the sand bed between two stationary side shrouds—creating the effect of a series of moving, closed, washing compartments.

The only outlet from these compartments is via holes in the belt above. Surplus liquid and slimes discharge through these "overdrain" holes without mixing with the oncoming sands. The end result is an extremely clean sand discharge, excellent de-sliming—making the "Overdrain" Classifier an ideal washing device.

Write for Hardinge Catalog 39-C— 11



Section through "Overdrain" Classifier showing upward-moving, closed, washing compartments.

Unretouched photograph of "Overdrain" action above the belt—water and slimes discharging upwardly.

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PEOPLE . . .

LETTERS:

Pro: Foolproof Protection

Sir:

I would like to comment on Mr. Bigham's fine article on "Rupture Disk Installations" in your Apr. 7 issue (pp. 143-5).

Fig. 4 of the article showed two disks, A and B, separated by a spoolpiece, to which is connected a pressure gage. Thus, a pinhole in Disk A would pressurize the spoolpiece and cause an indication on the gage.

Assume the vessel operates at 100 psig., Disk A is rated at 150 psig. and Disk B at 150 psig. or greater. If a pinhole should exist in Disk A, the pressure in the spoolpiece would go up to 100 psig., the operating pressure of the vessel. Then, if a pressure surge should occur in the vessel, Disk A would not burst until the surge exceeded 250 psig., because of the 100 psig. backpressure in the spoolpiece.

This dangerous back pressure can be prevented by substituting a vented, visible liquid seal for the pressure gage. The bubbling liquid provides an indication of the leak and, being vented, cannot build up any back pressure. The liquid seal and its connected piping must be designed to prevent plugging from freezing, corrosion or polymerization.

NORMAN R. PRATT
Dow Chemical Co.
Midland, Mich.

Kiln Reduction Isn't New

Sir:

I have read with interest the article, "Rotary Kiln Enters Iron-Ore-Reduction Race," in your May 5 issue (pp. 52-4).

During 1944-5 the Bureau of Mines at Laramie, Wyo., operated a rotary kiln for low-temperature reduction of low-grade hematite from the Colorado Fuel & Iron property at Sunrise, Wyo. One nonferrous metal firm is today operating such a kiln to produce sponge iron used for copper precipitation.

In a properly designed kiln, control of temperature and at-

PRO & CON

C. H. CHILTON

mosphere is not too great a problem after the idiosyncrasies of the particular kiln and ore have been determined. The Laramie kiln was fired with gas, with the proper amount of air for practically complete combustion. It was equipped with special air ports of the writer's design for use when the reducing agent contained a high percentage of volatile material. Burning of these volatiles effectively preheated the load as it migrated to the higher temperature of the reducing zone.

Several carloads of the Laramie plant production were sent to a steel mill in the Rocky Mountain area and used in place of scrap iron in an open hearth. The steel produced was up to grade in all respects.

Apparently now, as it was then, steel manufacturers are reluctant to accept an idea that would cause them to deviate very much from the operation which developed around the abundance of high-grade iron ores of the "good old days."

G. M. SPENCE

Laramie, Wyo.

Pro: Programming

Sir:

The Subcommittee of One for Giving Editors Freedom to Spell as They D--- Well Please, part of a larger group believing Acceptable Spellings Listed by Webster Are Acceptable, wishes to take issue with Mr. Cortes (May 19, p. 204) regarding the baNNing of the word "prograM-Ming" because program has only one *m*. Our language today is rife with such double consonants.

I personally feel that Mr. Cortes is only stiRRing up a hornet's nest, or you might say his taPPing of the Pandora's Box of Inconsistent English Grammar Rules will be only the begiNNing of a series of comments on this matter. Because he lives in Long Beach, one would thing Mr. Cortes would be too

IS A-C POLYETHYLENE "X"* THE X FACTOR IN YOUR PROCESS?

Stories of successful application of A-C POLYETHYLENE are pouring in from so many fields and industries that we haven't had an opportunity to explore the apparently limitless uses of this exciting new polymer. So we're asking you! If your field of operation is even remotely similar to those below, it is very probable that A-C POLYETHYLENE can give you increased sales, lower costs and many other advantages. Find out today!

Look what it's done for others!

X **Injection Molders** are getting shorter cycles, complete control of flow, higher gloss, sure mold release, with the ability to mold larger and more intricate parts.

X **Polish Makers** use it in its emulsifiable form and call it the "Polish Maker's Polyethylene". They're getting finish durability, non-slip properties, and rebuffability!

X **Paper Converters** use it as a hot melt and are enthusiastic about the low-cost quality coating it offers. Grease resistance, scuff resistance and single feed to automatic machines are other advantages!

X **Dairy Carton Coaters** add it to waxes for their cartons, getting longer shelf life and reducing flaking, leaking and bulging!

X **Food Packagers** like the smarter, glossier appearance of their packages—less rub-off and scuff. Printing looks better, too!

X **Box Makers** coat interior surfaces of corrugated cartons with an A-C POLYETHYLENE-Paraffin blend to eliminate the need for liners! Scratch from paper fibers on fine finishes is eliminated!

X **Textile Finishers** find A-C POLYETHYLENE surprisingly versatile for sizes or finishes. Excellent hand, sewability, durability, abrasion resistance and many production advantages result from using this polymer!

X **Ink and Paint Manufacturers** are satisfied that A-C POLYETHYLENE adds anti-smudge and scuff resistance characteristics to their products!

X **Slush Molders** use A-C POLYETHYLENE with other polyethylenes and end up with a "brand new" material, giving them simpler production with lowest mold costs. The finished articles are tough, colorful and have fine detail!

X **Film Extruders** are using A-C POLYETHYLENE for faster extrusion rates, lower machine temperatures, easier gauge control and less all around machine stress. A-C POLYETHYLENE is a natural for coloring films. Color concentrates made with A-C POLYETHYLENE produce brilliant, uniformly colored film!

X **Squeeze Bottle Makers** are praising the glossy finish and even color when using A-C POLYETHYLENE. They like the faster molding operation, too!

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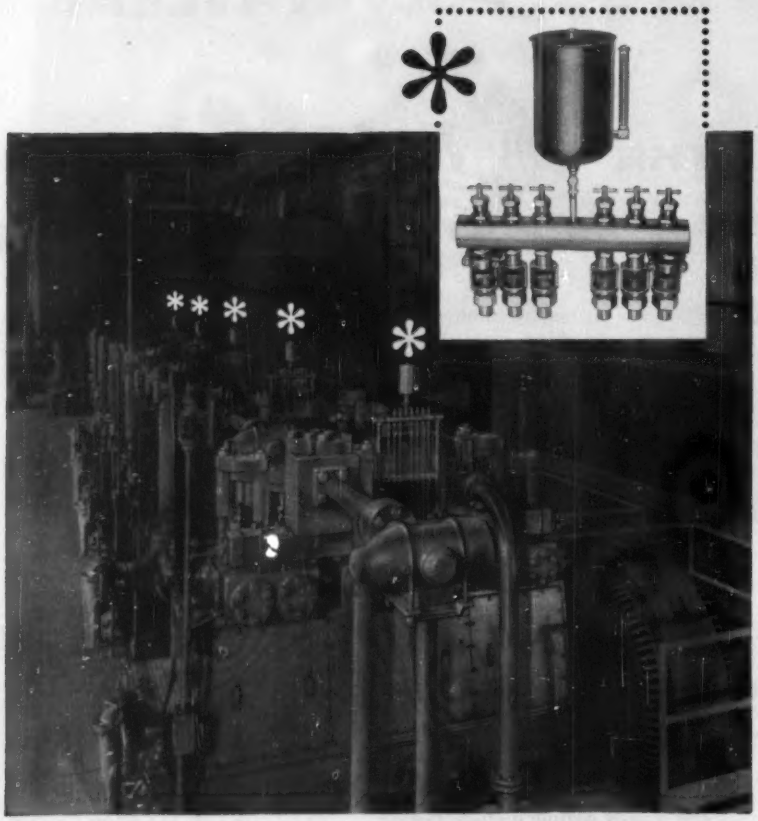

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MULTIPLE GRAVITY OILERS Provide Controlled Lubrication for hard-to-reach bearings

The five Worthington Power Pumps shown above supply hydraulic power for a central hydraulic accumulator system in a large aluminum mill.

Each pump is equipped with a Nugent Multiple Gravity Oiler. The feeds may be individually controlled to deliver lubrication in predetermined quantities to otherwise inaccessible bearings.

Nugent Multiple Gravity Oilers are available with 2 to 23 feeds. Pressure Sight Flow Lubricators are also part of a full line of Nugent lubricating specialties. Before you decide on any filtration or lubrication equipment . . . see what Nugent has to offer.

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busy swiMMing in the blue Pacific or taNNing himself on the beach to take pen in hand. However, since he has exposed this thorn in his beDDing, let us hope that its continued usage, as well as the computer jargon such as (ugh!) "debuGGing," will not give him a spliTTing (colloq.) headache.

May I take this opportunity to extend an invitation to Mr. Cortes to join our subcommittee. I would not think of baRRing him from membership merely because he exercises his freedom of leTTing the editor learn of his difference of opinion. We all have these differences occasionally.

Here's to the editor and his prerogative to use acceptable, as well as preferable, spellings if he so desires.

GEORGE W. DEAN
Monroeville, Pa.

Too Many Ch. E.'s

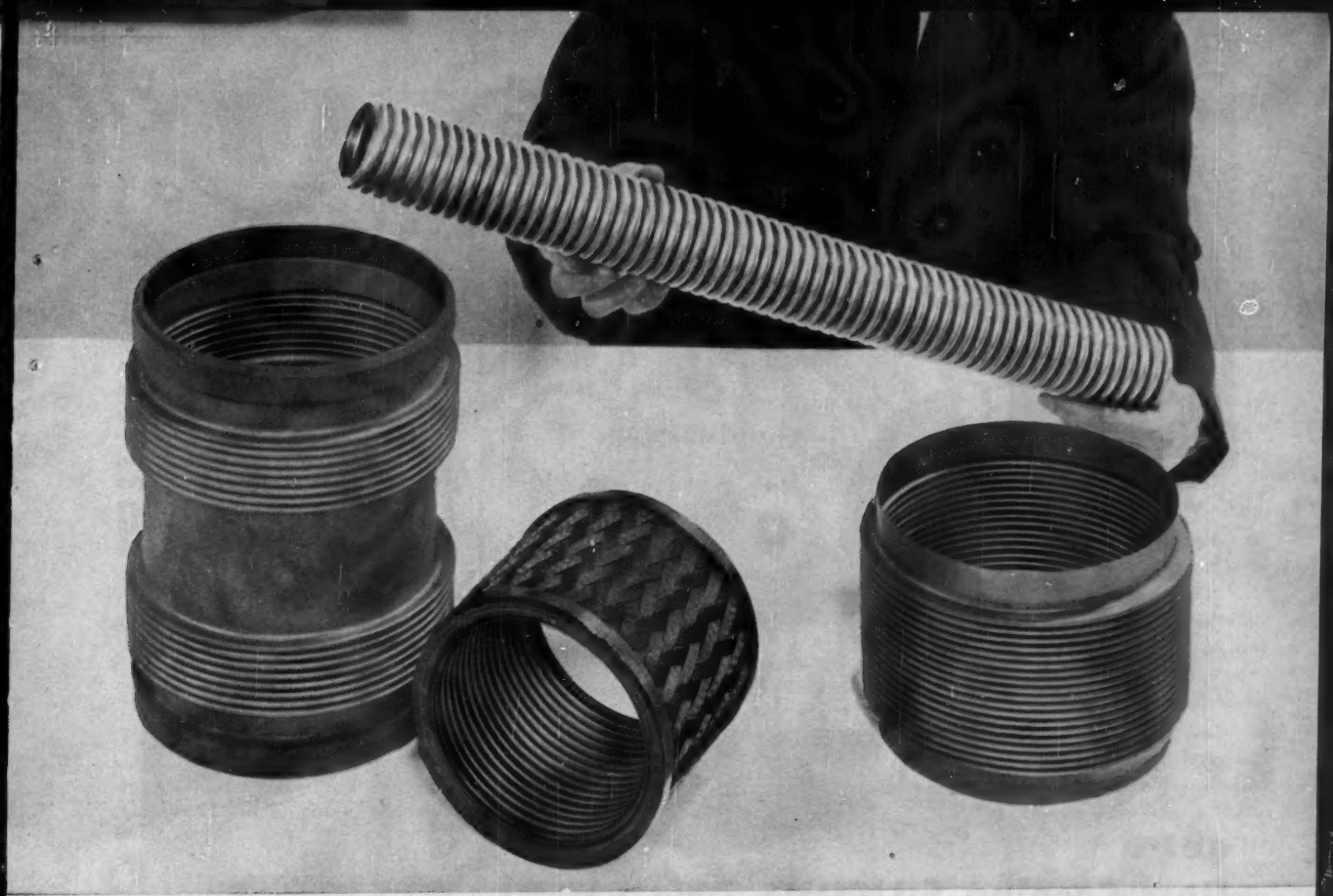
Sir:

Ray Fremed's letter to Dr. Katzen, published under the headline, "Chem. Engineers Continue to Lose Ground" (Mar. 24, pp. 161-4), appears to neglect currently available facts.

Last June, chemical engineering graduates commanded the lowest average salary of all major engineering groups. Electrical, metallurgical, industrial, mechanical and civil engineers commanded higher starting salaries than chemicals, in the order listed.

I infer from such statistics that the percentage of chemical engineers is too high, not too low. It used to be assumed that the difficulty of chemical engineering was at least comparable to that of electrical engineering and, therefore, chemical engineers should command equivalent salaries. This no longer appears to hold true.

The great pressures being brought to bear to encourage young people to enter fields of science and engineering apparently are already paying off in chemical engineering, dragging us to the tail end of the engineering field. Is this the "prestige" that AIChE and its Guidance Committee are delivering? I'm tempted to suggest that we



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My foamer is
Oil system
Aqueous system
Food products
Other

PRO & CON . . .

might be better off without their help and guidance.

Let's devote our efforts to the encouragement of high standards in our secondary schools and a simple, honest presentation of the facts of our profession. When these are unpleasant, they should be as forthrightly stated as are the advantages of an engineering career. Then let the young people of the nation chart their own courses as their personal desires and qualifications direct. We are of service to no one, least of all ourselves, when we attempt to pressure people into taking engineering.

R. C. VASEY
Concord, Calif.

Canada-U. S. Relations

Sir:

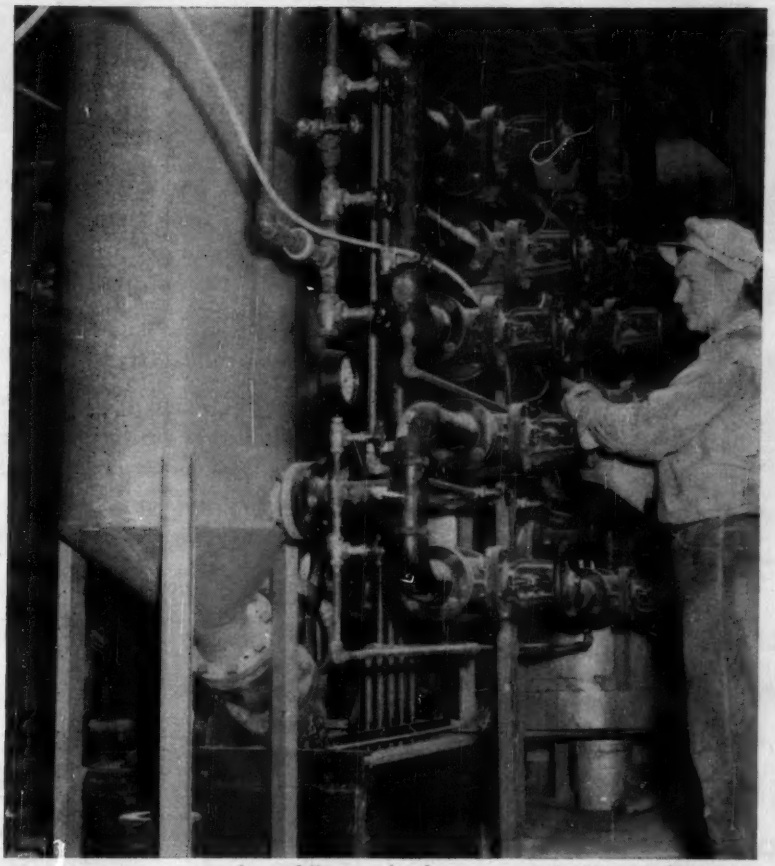
Your recent *Chementator* item, headlined "Yankee engineer go home" (May 19, p. 62), was written in a factual news style but was misleading in being incomplete.

I think you handled this particular subject too hastily. Impartial and complete reporting is of the utmost importance if we are indeed to achieve increased cooperation between engineers of Canada and the U. S. If this matter is of interest to you, then you as editor must bear a rather large share of the responsibility.

I believe you were correct in saying that 10% of Ontario's registered engineers are U. S. citizens. You failed to point out that engineers migrating from Canada to the U. S. will not obtain registration in some of your states (perhaps not any) without renouncing their Canadian citizenship and embracing yours.

Whether our freer acceptance of your citizens is good for Canada is a question only time will definitely answer. (I am inclined to favor it, along with other aids to Canada's growth.) But your much longer experience with growth by immigration has led you to be much more restrictive than we are.

NORMAN A. JULL
Professional Engineer
Toronto, Ont.
Canada



Successfully operating for over a year in the revolutionary new Unit 6 of the Philo Plant of Ohio Power Co., this Croll Reynolds ClaRite feedwater filter using SOLKA-FLOC filter aid has fully borne out its extensive pilot test predictions.

In feedwater purification— iron oxide cut from 200 to 1 ppb with SOLKA®-FLOC Filter Aid

The problem: Purifying feedwater condensate in the first commercial super-critical pressure steam generating plant.

The solution: Pre-filtration of the demineralizer influent to prevent rapid fouling caused by minimum amounts of suspended iron oxide. Extensive pilot tests proved that a filter station using SOLKA-FLOC, followed by a cation resin bed, cut feedwater iron oxide from up to 200 parts to one part per billion.

Whether your field is water purification, or whether it is heavy chemicals, food processing, pharmaceuticals, chromatography, beverages, textiles, plastics, stream pollution, or a long list of others, you can benefit from this versatile filter aid.

SOLKA-FLOC is economical, highly purified, finely divided cellulose. Besides improving filtration rates, it keeps screens cleaner, saves downtime, gives you more economical volume of clarified filtrate with minimum retention of filtrate in the cake.

Added advantages: It makes a stable pre-coat, does not bleed, prevents loss of cake from pressure drops, does not abrade pumps and valves. And SOLKA-FLOC *adsorbs* many metals such as iron, copper, other impurities.

Write us about your specific filtration problems. Address Dept. DF7, our Boston office.

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Chemical Engineering
Reader Service

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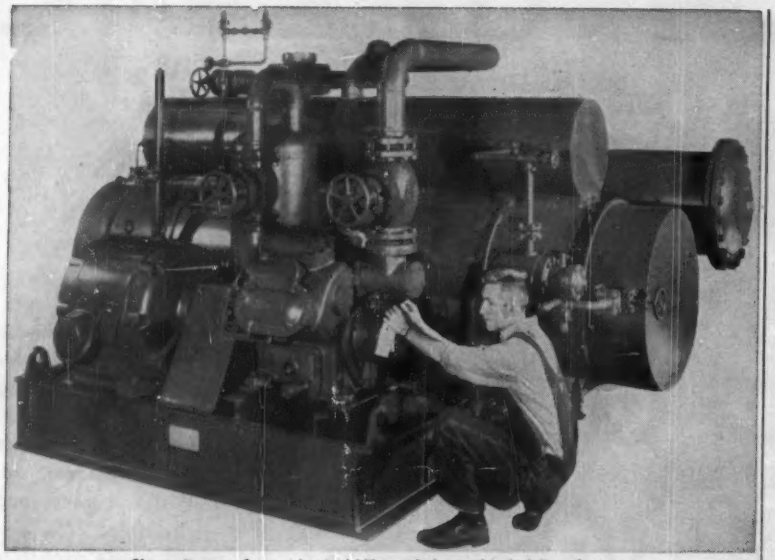

Shown is one of two identical Vilter ethylene glycol chillers factory assembled as a packaged unit for a large chemical company.

NOW, large-size, "packaged"

VILTER

HEAT EXCHANGERS

to meet your exact specifications

The above ethylene glycol chiller built for a large chemical company is factory assembled as a packaged unit. The principal Vilter components include: an 8-cylinder VMC ammonia compressor, 24" x 14' ammonia condenser, 12" x 12' liquid ammonia receiver, 30" x 12' flooded ethylene glycol chiller capable of cooling 405 gpm of 30% ethylene glycol solution from 25°F. to 20°F. The chiller has a 16" surge drum integrally welded to it. All electrical equipment is installed in explosion proof enclosures. It is typical of the custom work Vilter is doing in the field of heat exchangers and pressure vessels to meet design and budget requirements.

Vilter makes all four basic types of heat exchangers: shell and coil, shell and tube, shell and tube bundle, and atmospheric . . . and in every possible modification. Vilter can give you the most efficient heat exchange equipment with working pressures as high as 10,000 psi. Vilter is equipped to build vessels in conformance to both the A.S.M.E. Code and T.E.M.A. standards.

Today, more than ever before, the leading names in both the chemical and petroleum industries are turning to Vilter for their special vessel needs. Consult with Vilter about your needs.

Write for these helpful bulletins to The Vilter Manufacturing Company
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Air Units • Ammonia & Freon Compressors • Booster Compressors • Baudelot Coolers • Water & Brine Coolers • Blast Freezers • Evaporative & Shell & Tube Condensers • Pipe Coils • Valves & Fittings • Pakice & Polarflake Ice Machines

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Fiber Glass Finishing Agent.....Establishes better bond between fibers and resins. Reported to give better wet and dry strengths to polyester, epoxy, phenolic laminates.
33-34o *U. S. Industrial Chemicals Co.

Gratings, Steel ..... construct stair treads, walkways & floors with steel gratings for safer non-slip footing. For new ideas about grating, space saving platforms & shelving.
62 *Blaw-Knox Co.

Insulation.....Bulletin GER-1467 describes in text, tables and pictures the characteristics and application range of insulating materials that are compatible.
188C General Electric Co.

Linings, Corrosion Resistant.....Neoprene stops corrosion in refinery cooling lines, eliminates need for heavy-walled pipe, reduces costs. Write for Elastomers Booklet.
65 *Du Pont

Linings, Refractory.....new booklet is a guide for selection of refractories you need to improve production & cut costs in high temperature processing.
85 *Norton Co.

Linings, Tank.....Permobond is a corrosion resistant rubber lining which can be used in any container of corrosive acids, no matter how complex its shape.
163 *U. S. Rubber

Packings, Tower.....Check these features in packings by Knox, nonporous product, high chemical purity, wide range of sizes & designs.
BL197 *Knox Porcelain Corp.

Plastics, Industrial ..... 1958 catalog of industrial plastic materials gives current specifications and prices on most plastics in production today. Write for your copy.
189A Delta Products.

* From advertisement, this issue

LITERATURE

D. E. DETURO

Porcelain, Chemical ..... Have safer lines with less maintenance . . . install Lapp Tufclad, solid chemical porcelain armored with fiberglass-reinforced plastic.
63 *Lapp Insulator Co.

Primers.....Amercoat #86 resists undercutting & adheres tenaciously, inhibiting electrolytic corrosive action. To provide for long term protection write us now.
159 *Amercoat Corp.

Refractories ..... Two new bulletins about the properties & applications of our new refractories. Get your free subscription to our monthly brochure in addition.
61 *Carborundum Co.

Rubber, Butyl.....The greatest rubber value in the world, super-durable with outstanding resistance to aging, abrasion, chemicals, & chipping. Write for data.
89 *Enjay Co.

Sealing Compound, New Thread..... For liquid oxygen systems. Bulletin #1379 may be had on request. Is claimed to have approval of several rocket motor manufacturers.
33-34p *U. S. Industrial Chemicals Co.

Steel, Glassed.....If you have ever crazed a glassed-steel vessel from thermal shock, look at Bul. 968 which describes thermal shock resistant products.
8-9 *Pfaudler Co.

Steel, Stainless.....Equipment for high heat & corrosion resistance wears better & lasts longer when built of Stainless Steel. If you want quality, specify U. S. Steel.
66 *U. S. Steel

Stitching, Metal.....A 16-page booklet gives detailed information on stitching metal to metal, or metal to non-metallic materials, and illustrates applications.
189B Acme Steel Co.

Electrical & Mechanical

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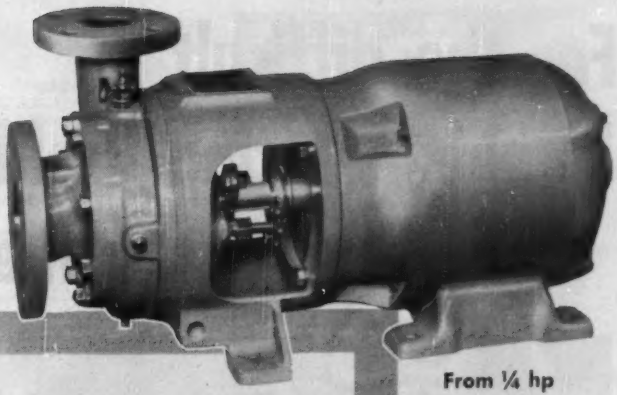

From ¼ hp to 75 hp

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WHEN YOUR IMPORTANT PRODUCTION depends on proven pumping power, you need the efficiency and reliability of I-R Motorpumps! Low maintenance and minimum down-time mean cost-cutting operation that continues to pay off year after year.

I-R Motorpumps are always available in the widest range of types and sizes for every type of installation. Capacities from 5 to 2800 gallons per minute; heads to 650 feet.

Compact Motorpumps are easy to install. They operate in any position, save valuable floor space. Write today for specifications and performance data.

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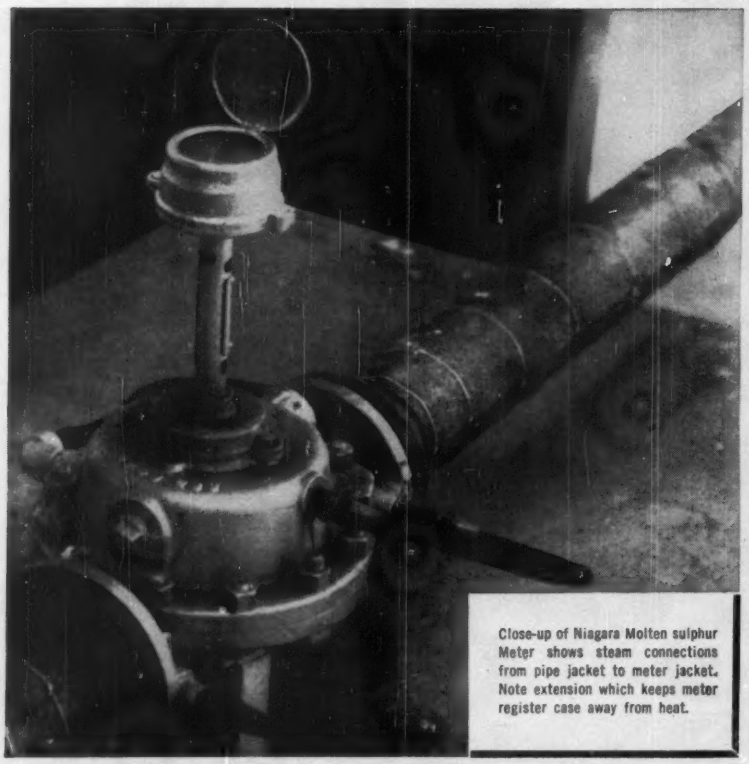
For the difficult Liquid Metering Problems Use Niagara Meters



Close-up of Niagara Molten sulphur Meter shows steam connections from pipe jacket to meter jacket. Note extension which keeps meter register case away from heat.

● Niagara displacement type liquid meters have a surprising range of applications. Their ultra-simple design, and variations of materials enable them to operate under most difficult conditions.

For example:

In the production of sulphuric acid it is desirable to measure the amount of sulphur fed to the burners so that the efficiency of the process can be checked. A Niagara Meter with a steam-jacketed cast iron casing and stainless steel working parts was selected for the job.

Since April of 1955 more than two million gallons of lime neutralized and filtered, dark Louisiana sulphur have been metered at a rate of 560 G.P.H. . . . without a shutdown for repairs or maintenance.

There is a dependable Niagara Meter to meter almost every liquid including caustic soda, sulphuric acid, soap, petroleum products, fruit juices, calcium chloride, alum and many others. The Niagara water meter line is standard for cold or hot water measurement.

Please send me information on Niagara Chemical Meters.

Liquid.....

Flow g.p.m.....Temp.....

Name.....

Company.....

Address.....

BUFFALO METER CO.

2891 Main Street

BUFFALO 14, NEW YORK

LITERATURE . . .

Anodes.....The superior performance of GLC's anodes is derived from the fact that they are custom made to meet individual cell requirements. Request complete data.
104 *Great Lakes Carbon Corp.

Drives, steel mounted.....If you require an efficient speed reducing unit to fit in limited space, Falk's drive meets your need. Bulletin 7100.
46 *The Falk Corporation

Electrical Equipment.....New 12-page pictorial bulletin emphasizes the variety of equipment available in condulet, floodlight, aviation and traffic-control product lines.
70 Crouse-Hinds Co.

Gaskets.....Bulletin AD-104 describes the complete line of spiral wound gaskets for high temperatures & pressures. Teflon jacketed gaskets for glass pipe flanges.
40 *Garlock Packing Co.

Generators, Steam.....Write for bulletins on Vogt's complete line of custom built & package type steam generators. Available in bent & straight tube designs.
128 *Henry Vogt Machine Co.

Motors.....with more stator protection provided by extra dips & bakes, more corrosion resistance, & more cooling surface, it pays to look into A-C motor data.
64 *Allis-Chalmers

Motor, Immersible.....built to operate in water, sewage, or liquid chemicals. Motor is oil-filled, diaphragm breathers equalize pressure at shaft seal. Bul. 2300.
167 *Louis Allis Co.

Motors, Sealedpower.....These units include Dripproof-protection and explosion-proof designs. The C-W design provides more cooling area. Bulletin PB6000-6.
22-23 *Elliot Company

Motors, Tube-Type.....Bulletin portrays the motor's tube-type air-to-air heat exchanger system, bearings, frame, stator, and rotor. Bul. 51B-8991.
190A Allis-Chalmers Mfg. Co.

Packings & Gaskets..... Teflon-asbestos valve stem packing combines heat & corrosion resistance. Moulded rings & spiral-wound gaskets for high pressure uses.
116 *Johns-Manville

Steam Turbine, Multistage.....Covers a range from around 200 to 3,000 hp. Impulse-type unit employs a multiple-velocity stage followed by Rateau stages.
190B The Terry Steam Turbine Co.

Switch, Interrupter.....Power switching centers with interrupter switches are built for safer operation—even against short circuits. Complete information available.
125 *I-T-E Circuit Breaker Co.

Traps, Steam.....The 44-page Armstrong Steam Trap Book covers the excellent air handling characteristics and other features of company's steam traps.
112 *Armstrong Machine Works.

Handling & Packaging

* From advertisement, this issue

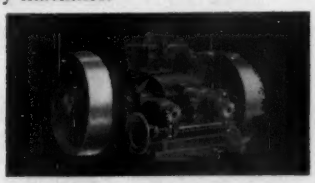
Take Guesswork Out of Lab Crushing & Grinding

Sturtevant Design Provides Easy Access for Cleanouts — Returns Complete Sample

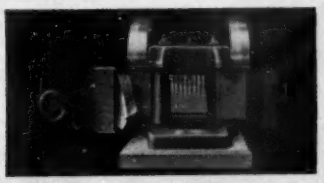
In seconds, because of "Open-Door" accessibility, all Sturtevant crushing or grinding parts are exposed for thorough cleanouts. 100% sample return is easy to secure.

Sturtevant laboratory machines are ruggedly constructed — design, based on production models, gives top lab or pilot performance.

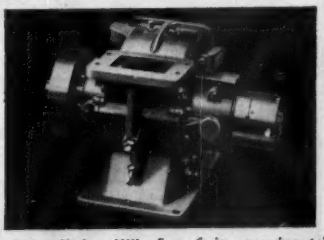
Send for Bulletin No.067, which gives full description of all Sturtevant laboratory machines.



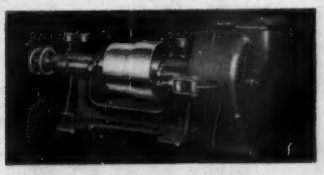
Lab Crushing Rolls: Special lab design. Two models: 8 x 5 in. and 12 x 12 in. rolls. Capacities to 10 tph. Both models adjust down to 20 mesh. Tires of high carbon forgings. Automatic feeder, adjustable controls.



Lab Jaw Crusher: Crushes hardest rocks at ½ to ⅛ in. settings. Roll jaw action — no clogging. Feed opening 2 x 6 in. Capacity to 1900 lbs. per hr. at ½ in. setting. Instant adjustment. Manganese jaws, reversible shield.



Lab Swing-Sledge Mill: 5 x 6 in. opening takes soft, medium, tough or fibrous feed. Capacity to 1 tph. Fines regulate from 1 in. to 20 mesh. Choice of gratings, hammers (or knives).



Sample Grinder: Disc type grinders for dry, friable soft or medium materials. Three sizes — 6 in., 10 in., and 14 in. take feed as coarse as ¼ in. Produces 100 mesh fines at capacities to 200 lbs. per hr. on largest model. Regulate 10 to 100 mesh. In-operation adjustment.

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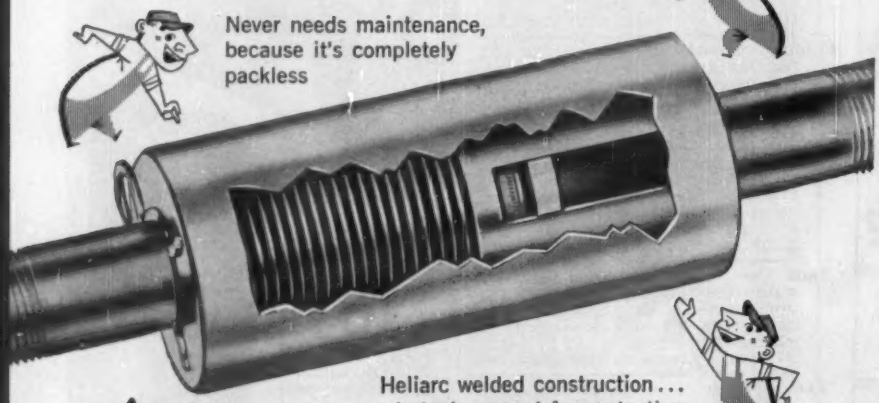

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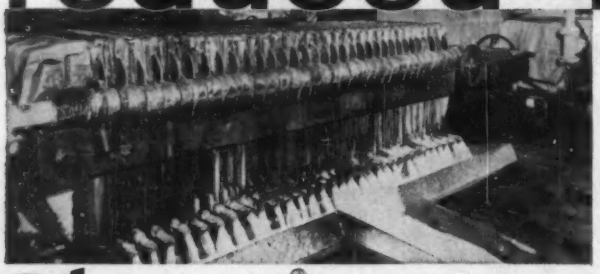

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TR205 *Marsh Instrument Co.

Instruments.....Hermetic sealing characterizes RMC's thermometers. Locks out moisture, cannot be affected by bimetal freeze-up. Liquid level gauges also offered.
108 *Rochester Mfg. Co.

Meters.....For cold or hot water measurement Niagara meters have a surprising range of application. Operate under the most difficult conditions. Write for information.
188 *Buffalo Meter Co.

Meter, Gamma-Beta Survey.....Portable model for fast response time eliminates need for two separate instruments. Write for free technical literature and price lists.
177 *Riggs Nucleonics Corporation

Meters, Liquid.....if it's a liquid, Rockwell can meter it. Form 400-S-2 details metering variables, gives us the information needed to recommend the meter for you.
41 *Rockwell Mfg. Co.

Meters, Magnetic Flow.....for complete information on the meter that has no flow restrictions, specify Bulletin 20-14B. Handles all difficult liquids accurately.
39 *Foxboro Co.

Rectifiers, Silicon.....Higher efficiency, simpler construction for medium & low voltage processing economy. Write today for complete information.
11 *Westinghouse Electric Corp.

Rectifier Equipment.....custom engineered rectification in Semiconductor Power Conversion Equipment & Systems. Flexible designs to meet specific needs. "Guide".
196A Sel-Rex Corp.

Regulator.....Designed for extra long life. Write for Bulletin D-CN for information on this self-powered temperature regulator.
170 *Robertshaw-Fulton, Fulton Sylphon Div.

Regulators.....for extreme sensitivity Norwalk pressure balanced regulators give close control over wide ranges of gas flow. Data available on complete line.
R197 *Norwalk Valve Co.

* From advertisement, this issue

Regulators, flow-rate.....Cut your flow control costs without sacrificing performance. Don't build a system—install a Kates unit. Write for bulletins #561 & 562.
178 *W. A. Kates Co.

Pipe, Fittings, Valves

Compensators....high-pressure, heavy-duty expansion compensators cost much less per inch of stroke than any other method of absorbing pipe. Design & cost data offered.
190 *Flexonics Corp.

Hoses.....Made of thick, resilient rubber, which is designed to absorb pump vibrations traveling along pipelines. Your distributor has complete specifications.
216
*B. F. Goodrich Industrial Products

Nozzles, Spray.....for effective spraying at lower cost choose your spray nozzle from Catalog #24, a 48-page guide to spray nozzle selection.
T214 *Spraying Systems Co.

Pipe Fabrication.....A specialized activity at Vulcan is now offered. All work supervised by master metalsmiths on manifolds, jacketed or lined piping.
18-19 *Vulcan-Cincinnati

Piping, Shop-Fabricated.....fast & low cost erection characterizes Midwest piping . . . whether for refinery, power plant or industrial installations. Write for literature.
49 *Midwest Piping Co.

Tubing.....Tuff-Tube is the most effective plastic material to fight corrosion . . . requires no maintenance after installation . . . non-magnetic and non-sparking.
R202 *Lamtex Industries, Inc.

Tubing, Flexible Metal.....Large-diameter flexible metal connectors in stainless steel & other alloys to handle expansion & contraction, corrosive fluids, etc. Catalog.
183 *American Brass Co.

Valves.....Behind every Aloyco valve there is specialization to help you handle corrosives. For staying power & minimum maintenance, find out about Aloyco valves.
54 *Alloy Steel Products

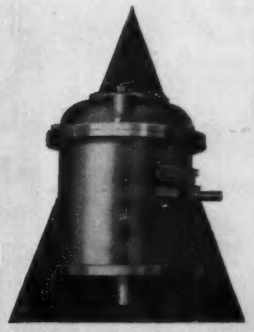
Valves.....low cost of valving for difficult processing of corrosive chemicals. Available in a wide range of metal combinations & in several different styles.
48 *De Zurik Corp.

Valves.....Cupola back pressure valve is also adapted to air lines in industrial plants where weight is a factor. Installation, sizes, etc., in detail . . . see Bulletin I0000.
198A Norwalk Valve Company

Valves.....Multiport valves are used in process industries for batching and product flow control. Efficient where flow must be stopped or relieved.
107 *Rockwell Mfg. Co.

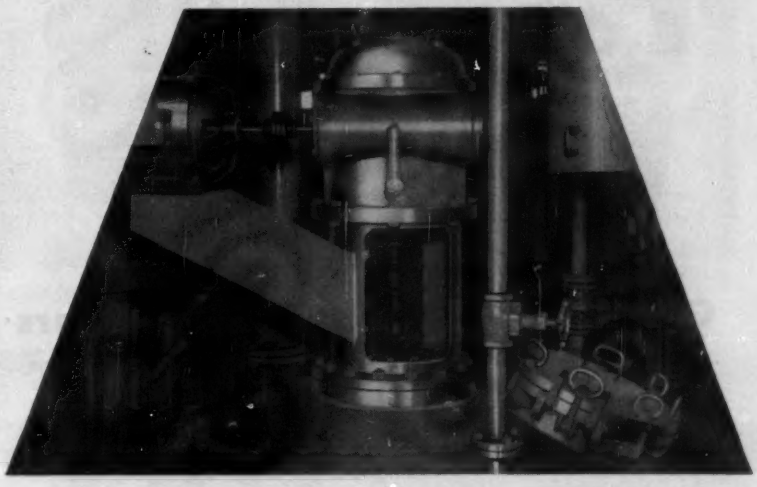
Valves.....All plastic solenoid has no metal contact with the fluid and outlasts stainless steel valves. Send for new catalog for pertinent application details.
169 *Valcor Engineering Corp.

* From advertisement, this issue



GET PRODUCT UNIFORMITY FASTER and at LESS COST

. . . with NETTCO Engineered Agitation!



INCREASE PRODUCTIVITY, lower power costs, and minimize maintenance requirements . . . with "process-rated" Model WT agitators by Nettco. Standardized components (motor, drive, shaft, stirrer) can be combined to suit your most exacting size, speed, HP or other process specifications. Check the design features of the Model WT tank top agitator . . .

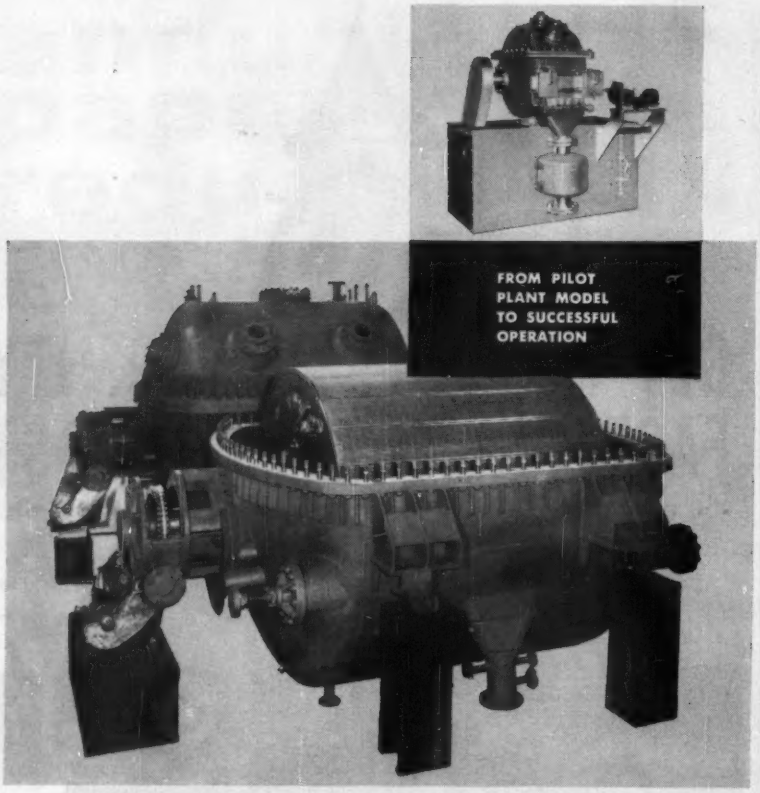
- Worm gear reduction drives
- Ratios from 3.5:1 to 68:1
- Seven sizes available
- Complete range of speeds
- Minimum moving parts
- Large diameter vertical shaft
- Widely spaced, oversized Timken bearings
- Fully enclosed — dust, fume, moisture-proof
- Splash lubrication, drip-proof design
- Oil-trapped against leakage

Model T units, featuring helical gear trains and worm gears in combination, offer ratios from 6.25:1 to 100:1 in numerous "process-rated" models designed for dependable, economical operation. Ask Nettco agitation engineers for recommendations. Request Bulletin 551 and data sheet from **New England Tank & Tower Company, 87 Tileston Street, Everett 49, Mass.**

NETTCO
ENGINEERED AGITATION

FREE LITERATURE

Please send me the following literature:
☐ Tank Top Agitators—Bulletin 551
☐ Portable & Tripod Mixers—Spec. Sheets
☐ Pipeline-Flomix®—Bulletin 531
☐ Side Entering—Bulletin 532



G-B Rotary Drum Pressure Filters for HIGH PRESSURE

This new filter was originally developed for the lubricating oil industry where high pressure is necessary to keep the solvents used from flashing. The two units shown above were recently installed in a foreign country for a propane dewaxing plant.

This filter has now been adapted for other uses such as high energy boron fuels, refractory materials and other high pressure, high temperature applications. It is available from 6 sq. ft. to 400 sq. feet and in pressures to 150 psig. Stainless steel, monel or nickel construction may be used in addition to mild steel. A 6 sq. ft. pilot plant model in stainless steel is available for rent as shown in the inset above.

GB

GOSLIN-BIRMINGHAM
MANUFACTURING CO., INC.
BIRMINGHAM, ALABAMA

FILTERS • EVAPORATORS
PROCESS EQUIPMENT
CONTRACT MANUFACTURING
including HEAVY CASTINGS

LITERATURE . . .

Valves, Diaphragm.....Maximum flow, minimum turbulence, negligible pressure drop is insured with these Straightway valves. Information available on request.
115 *Grinnell Co.

Valves, Feather.....The lightest, fastest-acting compressor valve available. Lightness & flexibilty eliminate slips & backflow. Inquire about our Feather Valves.
67-680 *Worthington

Valves, gate.....Exceptional performance. Longer valve life, less maintenance, easier operation. Made in various alloys, types and sizes for most services.
30 *Darling Valve & Mfg. Co.

Valves, plug.....Efficient, economical chemical service with W-K-M plug valves. Permits full flow, has quick on/off control, and is corrosion resistant.
103 *W-K-M, ACF Division.

Valves, Pressure Reducing.....For extremely accurate, long trouble-free service, put a Fisher 92B in the line. I pilot with 3 interchangeable springs. Bulletin D-92.
45 *Fisher Governor Co.

Valve, Spray.....solenoid valves control pressure surges in nuclear reactions. ASCo now offers a family of valves designed for atomic energy applications. Cat. #202.
97 *Automatic Switch Co.

Valves, Wedge Disc.....Find out how one Crane valve controls two-fluid process. For information about the efficiencies & obvious economies of this valve, request data.
95 *Crane Co.

Valves & Fittings, PVC.....Made of non-aging, non-corrosive and non-toxic unplasticized rigid polyvinyl chloride. Highly resistant to chemical attack. Booklet.
217 *Walworth Co.

Process Equipment

Agitator Equipment.....minimum moving parts . . . dust, fume & moisture-proof. Anti-friction bearings, large diameter "stepped" vertical shaft.
195 *New England Tank & Tower Co.

Blenders.....Insure maximum uniformity of product with Thoroblender. Air-fed from storage bins to giant machine, product touches only stainless steel.
53 *Patterson Foundry & Machine Co.

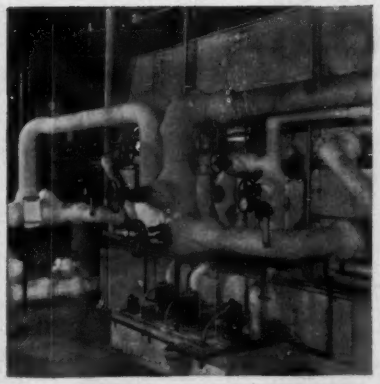
Centrifuges.....brochure on De Laval line of centrifuges for process industries gives specifications. High-capacity centrifuges offer savings in manpower & space.
87 *De Laval Separator Co.

Centrifugals, Filtering Built in a wide range of sizes & types, so whatever your needs may be, there is a B-P unit to do the job. Uniform moisture content product.
43 *Baker Perkins Inc.

Classifier, Wet.....New classifier has belt, with lifting flights attached beneath; moves upwardly out of the sand bed; creates the effect of moving washing compartments.
180 Hardinge Co., Inc.

* From advertisement, this issue

. . . a machine with "A GOOD RECORD as a REVENUE PRODUCER"



A typical case of using a Niagara Aero Heat Exchanger to provide cooling for production equipment shows amortization of this machine in 16 months and $90 per day revenue thereafter.

Industrial engineers with careful cost, upkeep and revenue records on all machines, credit Niagara Aero Heat Exchangers with important gains over other methods.

They use these machines to provide cooling for production equipment, welders, extruders, drawing dies, furnaces, quench baths, plating, chemical and electronic process...all millwater system uses.

They get positive control of critical process temperatures with improved product quality, rejection losses prevented. Heat is removed at the rate of in-put.

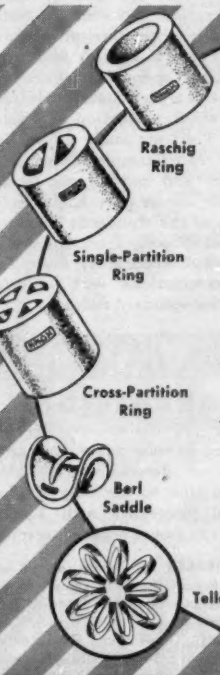
A closed system, dirt free prevents all troubles from bad water; transferring heat to the atmosphere by the evaporation of a very small amount of water solves all problems of water supply or disposal.

Write for Bulletins 120, 135

NIAGARA BLOWER COMPANY

Dept. CE-7, 405 Lexington Ave., New York 17, N.Y.

Niagara District Engineers in Principal Cities of U. S. and Canada



CHECK THESE FEATURES in TOWER PACKINGS by KNOX

- ✓ Modern production techniques assure non-porous tower packings.
- ✓ Uniform quality — high chemical purity — iron free — great mechanical strength — will not crumble.
- ✓ Wide range of designs, with adequate stocks maintained for emergencies.
- ✓ Better Tower Packings at lower operating costs. Prices and samples will be sent on request.

KNOX is pleased to announce the handling of a new light weight packing in the unique polyethylene Tellerette.

KNOX PORCELAIN CORPORATION

KNOXVILLE 1, TENNESSEE

Always Specify KNOX *Tower Packings*

Spring Loaded Appliance Regulator. Model 5500M

For extreme sensitivity

Norwalk

PRESSURE BALANCED REGULATORS give close control

Norwalk's custom built commercial and industrial appliance and service regulators are extremely sensitive and give close control over wide ranges of gas flow. Spring loaded and dead weight models. Inlet pressures to 100 psi and outlet pressures as low as 3" WC—pipe sizes from ½" to 24".

Norwalk Regulators, individually tested to meet special as well as standard needs, provide the safety and low maintenance costs that have made Norwalk Valves famous for dependability for 80 years.

For positive control of gas and air—

Call Norwalk.

Industry's Complete Line

Check Valves Pipe Sizes ⅜" to 42". Screwed and Models to 4".
Manometers Pressure or Vacuum.
Pressure Controllers Pressures to 5 psi.
Appliance Regulators Pipe Sizes ½" to 2".
Station Regulators Pipe Sizes 3" to 24". Liquid Seal or Diaphragm Types.
Relief Valves Pipe Sizes ½" to 24".
Filters Pipe Sizes ½" and up.

Complete Engineering Cooperation

NORWALK VALVE CO.

Established 1878

SOUTH NORWALK, CONN.

Boston • Chicago • Cleveland • Detroit
Los Angeles • Minneapolis • New York
Philadelphia • Pittsburgh
San Francisco • Washington, D.C.

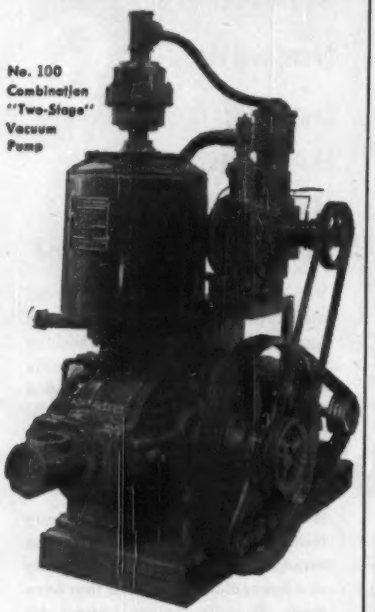
In Canada: Onter Ltd., Toronto • Bascom Corp., Ltd., Montreal

the

Beach-Russ

Combination

"TWO-STAGE" VACUUM PUMP



No. 100 Combination "Two-Stage" Vacuum Pump

The Beach-Russ Combination "Two-Stage" Vacuum Pump gives tops in service at the low micron range.

- Faster Pump-Down
- Faster Recovery
- Lower Blank-Off Pressure
- Conditioned Oil Supply
- For Dry or Wet Systems

Write today for NEW "Two-Stage" Bulletin 95

BEACH-RUSS COMPANY
50 Church St. · New York 7, N. Y.

LITERATURE . . .

Crushers & Shredders.....Company offers four bulletins on processing equipment—#910, Hogging Units; #920, Wastes Utilization; #930, Impact Crushers; & #940, Shredders.
TL215 *Gruendler Crusher & Pulverizer

Crushing & Grinding.....Sturtevant laboratory machines can expose all crushing or grinding parts for thorough cleanouts in a matter of seconds. Ask for Bul. 067.
L189 *Sturtevant Mill Co.

Dryers.....Five different drum dryers are part of a complete line that includes atmospheric and vacuum types, with chamber, pan, rotary, spray and other models.
31 *Blaw-Knox Co.

Dryers.....Choose Lectrodryer for dependable drying . . . whether for drying air, gas or organic liquid. Let our engineers help you select the right equipment.
171 *Pittsburgh Lectrodryer Co.

Dryers, Gas.....to keep down-time down use a gas dryer. End costly shut-downs by protecting air- operated instruments from corrosion. Bul. D-100.
35 *C. M. Kemp Mfg. Co.

Dust Controls.....Bulletin 917 "Out of the Realm of Dust" presents the full story on dust control installation for use in many diversified industries.
56 *Pangborn Corp.

Dust Collectors.....Self-cleaning 18" cyclone tube solves problems of dust collection. Greater capacity with less air flow resistance. Bul. D-584.
BR215 *Dustex Corp.

Filters.....save two ways with new hi-acpacity filters through improved production & decreased downtime. Sturdy steel filters available in a full range of sizes.
200A Commercial Filters Corp.

Filters.....Designed for all vacuum filter applications. Bulletin #KSI-2-3 detailed information and illustrations plus specifications of Pilot Plant Equipment.
200B Komline-Sanderson Engr. Corp.

Filters.....five bulletins offered on vertical leaf & batch, horizontal leaf & batch, & cartridge filters. Wide range of accessories. Specify bulletin from ad.
44 *Process Filters, Inc.

Filters, Precoat.....infinitely variable knife advance and power retraction are the features of our unit. Custom filter design begins with your filtration problem.
55 *Filtration Engineers

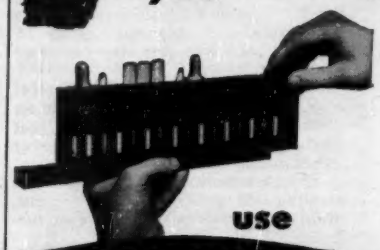
Filters, Rotary Drum.....Developed for lubricating oil industry where high pressure is necessary to keep solvents from flashing. Used wherever high pressures are needed.
196 *Goslin-Birmingham

Filter, Rotary Vacuum.....If a closed system is desired, you owe it to your product & reputation for low cost processing to find out what this Bird filter can do for you.
4 *Bird Machine Co.

Filter, Vertical Plate.....This filter is particularly suited for toxic & volatile products. Available in capacities from 100 to 1000 sq. ft. Spent cake easily removed.
47 *Sparkler Mfg. Co.

* From advertisement, this issue

if accurate pH, CHLORINE tests are *important* to you—



use

TAYLOR COMPARATORS

Taylor Comparators combine the maximum of accuracy with ease and simplicity of operation. Colorimetric tests for pH, chlorine, phosphate, nitrate are completed in only minutes. And, you get dependable operational data to help you control crystallization, bleaching, precipitation, extraction or waste treatment. Tests are made simply by placing the treated sample in the middle test tube and moving the color standard slide across until the sample matches one of the standards. Values are then read directly from the slide. Many Taylor Comparators serve for several determinations with only a change of color standard slides.

COLOR STANDARDS GUARANTEED

All Taylor liquid color standards carry an *unlimited guarantee against fading*. Be sure to use only Taylor reagents and accessories with Taylor Comparators to assure accurate results.

SEE YOUR DEALER for Taylor sets or immediate replacement of supplies. Write direct for FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes complete Taylor line.

W. A. TAYLOR AND CO.
414 STEVENSON LANE • BALTIMORE 4, MD.

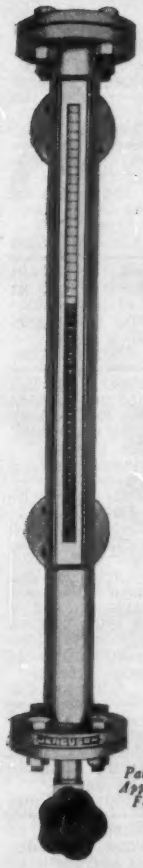
Announcing

the New

Jerguson

MAGNETIC GAGE

For Liquid Levels



An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

For pressures up to 2500 lbs. @ 600° F.

Patent Applied For

Can also be used for interface indication.

Write now for engineering sheet on Jerguson Magnetic Gages.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

100 Adams Street, Burlington, Mass.

Offices in Major Cities

In Canada: Peacock Bros. Ltd.

LITERATURE . . .

Filter Aid.....Solka-Floc gives best results whether your field is water purification, food processing, pharmaceuticals or textiles. Economical and highly purified.
185 *Brown Company

Filter Paper.....Netone features less installation damage, service life of 12 cycles and excellent resistance to solution shock. Test samples on request.
194 *The National Filter Media Corp.

Floats....Complete technical data is available in Harris Floats catalog. Experienced engineers will help you select the right type for your installation.
TL203 *Arthur Harris & Company

Kilns.....Kennedy Rotary Kilns designed for efficient operation over longer periods. Built in any length or diameter for Lime, Cement-wet or dry process and drying.
168 *Kennedy Van Saun Mfg. & Engr.

Laboratory Ware, Plastic ..... chemically resistant polypropylene lab equipment available. PVC tubing, tube fittings & recovery traps in assorted plastics. Catalog #G358.
202A The Nalge Co., Inc.

Mixers ..... What mixing operations are important to you? You'll find a wealth of information in the helpful bulletins listed in our ad. Fluid mixing specialists.
218 *Mixing Equipment Co.

Mixer, batch ..... produces finished product in one operation. Better wetting, dispersion & blending. Send samples for trial processing. Ask for catalogue.
B214 *Troy Engine & Machine Corp.

Mixers.....disperses, mills, blends & emulsifies in one operation. Write for Catalog 78 for data on the mixer that gives speed & power & is easy to clean.
166 *Abbe Engr. Co.

Mixers.....Mix-Mullers give positive moisture control, intensive blending and controlled dispersion. They can be used to prepare any dry or wetted solid.
126 *National Engrg. Co.

Mixers ..... Company designs and builds complete mixer unit—mixer drive, shafting, impeller & coupling. Six standard models & special units available. Cat. A-27.
12 *Phila. Gear Works.

Mixers.....You'll cut processing time, increase mixing efficiency with Readco Mixers. Counterflow is key to rapid thorough mixing. Spiral ribbon design.
101 *Read Standard

Mixer Drives ..... Complete interchangeability featured in "International" types. Users benefit thru standard parts. Fast factory and warehouse service.
212 *International Engineering, Inc.

Oilers, Multiple Gravity.....Provide controlled lubrication for hard-to-reach bearings. Before you decide on filtration or lubrication equipment, check on Nugent.
182 *Wm. W. Nugent & Co.

Process Equipment.....Blending systems, filter dust collectors & sifters are only 3 units in S-P's complete line of industrial equipment. Full story in Bul. Vol. 7 #3.
106 *Sprout, Waldron & Co.

* From advertisement, this issue

Locate Leaks The Easy Way

With General Electric's new and complete line of leak detectors

G.E.'s versatile, Type H halogen leak detectors locate leaks quickly and accurately in any system or component under pressure or vacuum. They are easier to use and much more sensitive than ordinary methods of leak detection.

(A) Standard control unit is used with any one of the following detectors: (B) gun detector, (C) stationary detector, (D) vacuum detector, (E) pencil-probe detector.

For more information write for Leak Detector Bulletin GEA-6817. Section 585-67, General Electric Company, Schenectady, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

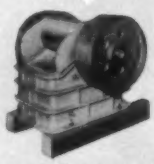
Look to **DENVER** for the ANSWER

Wet or Dry Grinding

DENVER designs and manufactures a complete line of size reduction equipment engineered to the individual requirements of your plant, including Steel Head Ball and Rod Mills, Jaw Crushers, Wet or Dry Grinding Systems, and complete laboratory grinding test service.

DENVER Steel Head Mills available in sizes up to 10′ dia. x 20′ long. Write for Bulletin No. B2-B20.

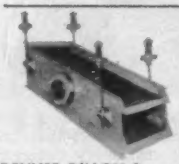
DENVER Equipment for the Chemical Process Industries



DENVER Jaw Crushers
Sizes from 2¼″ x 3½″ to 32″ x 40″
Write for Bulletin No. C12-B12

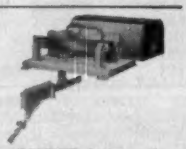
DENVER SRL Pumps
Capacity to 3000 g.p.m.
Write for Bulletin No. P9-B10

DENVER Agitators and Mixers
Sizes to 32′ x 32′ and larger
Write for Bulletin No. A2-B4



DENVER-DILLON Screens
Sizes from 1′ x 3′ to 6′ x 14′
Write for Bulletin No. S3-B15

DENVER Agitator-Type Disc Filters
Sizes to 9′ dia. x 12 Disc
Write for Bulletin No. F9-B5



DENVER Automatic Samplers
8″ to 120″ Cutter Travel
Write for Bulletin No. S1-B4

See our catalog on pages 647-654 in CEC Catalog

Specialists in Flotation Engineering

DECO ENGINEERING — DENVER EQUIPMENT COMPANY — 24 HOUR SERVICE — DENVER EQUIPMENT COMPANY

BOX 5268, DENVER 17, COLO.

LITERATURE . . .

Processing Equipment.....High speed roll mills and change can mixers provide efficient service. Mills are high speed with one point hydraulic roll adjustment.
L202 Charles Ross & Son Co., Inc.

Propellers..... Smooth, vibrationless propellers for mixing, stirring, aerating & pumping. Available for special application & replacement, as well as original equipment.
BL205 *Michigan Wheel Co.

Pulverizers..... the Mikro-pulverizer improves & increases outputs of rocket fuel, material, easy & safe handling of hydroscopic & highly explosive materials.
105 *Mikro-D Pulverizing Machinery

Pumps, Blowers, Compressors

Compressors.....Complete line of compressors and gas turbines, highlighting latest engineering and performance data in relation to application.
16-17 *Clark Bros. Co.

Compressor, Barrel-Type..... Boosts high pressure levels in range of 50 to 500 psia. Extends the range of single-stage units into levels handled by reciprocating types.
119 *Allis-Chalmers

Compressors, water-cooled..... Plain talk on our new units is found in any of 12 informative articles available on request. Specify the article you want from our ad.
67-68b *Worthington

Fans..... American Blower fans hit top efficiency at medium speeds with minimum fan size. Heavy-duty construction guarantees low-cost, minimum-maintenance service.
50 *American-Standard

Pump.....eliminates contact of movings parts with fluid handled. Bulletin #1373 explains that intake and outlet consists of one flexible tube passing through pump body.
33-34j *U. S. Industrial Chemicals Co.

Pumps.....H1 Durcopumps are heavy duty chemical pumps built to give long service life, minimum maintenance. Wide interchangeability of pumps is result of simple design.
161 *Duriron Co.

Pumps.....If a chemical can be pushed through a pipe, a Moyno can pump it. Exclusive "progressing cavity" & screw-like rotor insure reliable pumping.
51 *Robbins & Myers

Pumps.....Made of Nickel, Monel or Chrome-Nickel. Bulletin V-837 describes vertical pumps and Bulletin C-355 explains in detail the horizontal pumps. Both free.
R189 *Taber Pump Co.

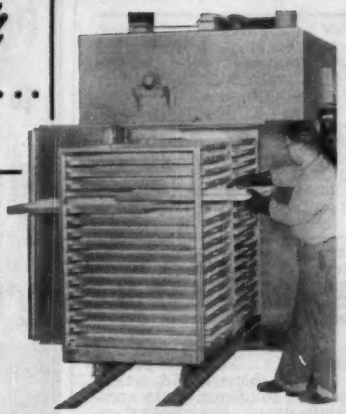
Pumps, Canned.....Bulletin 1070 describes high-pressure, zero-leakage motor pumps; Bulletin 1050-3 details features of Series C Chempumps.
203A Chempump Corp.

Pumps, Corrosion Resistant..... New corrosion resistant positive displacement pump has a maximum capacity of 300 G.P.M. Free bulletin is available to you.
165 *Waukesha Foundry Co.

* From advertisement, this issue

Despatch
Truck-loading . . .
Batch Type

CHEMICAL DRYING OVEN



- Models available in 3 temperature ranges
- Controlled exhaust of saturated air
- Complete removal of explosive volatile
- Available for gas, electric or steam
- Optional equipment includes loading truck, extra shelves, timed exhaust, special controls and larger capacities

Write for Bulletin 100

For convenience in handling large batches of chemicals, the Despatch No. V-39 is the answer—ideal, too, for finish baking, curing, aging, dehydrating or preheating any heat reactive product. The V-39 easily handles big fully loaded floor trucks that can be rolled right into the oven. Specially arranged horizontal ducts provide a uniform, high volume blast of air over and under each shelf to assure thorough drying. Available in 3 temperature ranges: Standard 100°-500° F.; Heavy Duty 250°-650° F.; Super Duty 450°-850° F.

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Three types of Water Ends: "R" for severe abrasion limited heads. End plate (entrance) secured to housing by easily removable dogs or clamps. "C" for purely corrosive applications, where inspection is infrequent; center-split casing, halves bolted together. "F" for abrasive and/or corrosive conditions under high pressures; end plate secured to housing by means of flanges and bolts.

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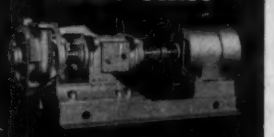
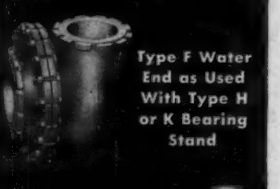
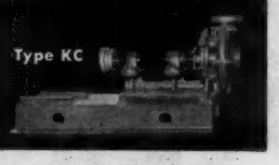


Type HR



Type F Water End as Used With Type H or K Bearing Stand



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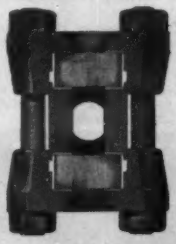

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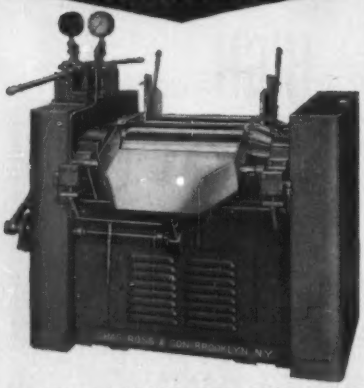

● Pressure indicating gauges provide greater ease in properly setting rolls, and less skill or experience is required by operator.

● Roll pressure settings can be recorded for exact reproduction of material assuring standardization of product.

● Special equalizers assure positive parallelism of roll faces at all times for uniform dispersions and minimum maintenance costs.

● Mills have quick roll release with safety overload feature, and are convertible for either fixed or floating center roll operation. 2½x5, 4½x10, 6x14, 9x24, 12x30, 14x32, and 16x40" sizes.

Production size dispersion type Change Can Mixers with— DOUBLE PLANETARY stirrer action.

● Stirrers with special blade angles and very close clearances revolve on their own axis and also around can, developing 12 intense compressive and shearing actions with each revolution to break down and disperse agglomerates.

● Variable speed for infinite range of stirrer speed control. ● Simplified vertical hydraulic lift for greatest ease in cleaning down stirrers. ● Non-revolving can is completely enclosed during mixing for safety and to reduce solvent loss. Cans can be jacketed or fitted with slide gate when required. Cans are easily positioned or removed from Mixer. ● Extra heavy construction and standard type motor eliminate costly downtime. Oversized motor drives can be provided for kneading and mixing extremely heavy materials. 1, 2, 3, 4, 6, 8, 12, 25, 50, 65, 85, 125 and 150 gallon sizes.

Area of can contacted by stirrers during only one revolution of stirrers around can (2 seconds). Position of stirrers advances 4½" with each successive revolution to sweep entire area and all points on sides of can. Stirrers overlap each other as well as center of can.

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187 *Ingersoll-Rand

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26 *Fairbanks-Morse

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L198 *Beach-Russ Company

Pumps, Vertical ..... Vertical pumps handle hydrocarbons, mild acids, basic and salt solutions. Outstanding suction head characteristics. Bul. B-1700.
113 *Peerless Pump Div.

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175 *The Ceilcote Company, Inc.

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BL-215 *Oxy-Catalyst Inc.

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27 *Aluminum Company of America

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124 *Hooker Electrochemical Corp.

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Chemicals..... Wyandotte's technical service can help you use chemicals more efficiently & economically. Send us data with the product characteristics you want.
109-110 *Wyandotte Chem. Corp.

Chlorine, Phosphate..... Why take chances? Use Taylor comparators for fast, accurate pH. Chlorine, phosphate or nitrate tests. Write for free handbook.
R198 *W. A. Taylor & Co.

Defoamer.....Silicone does the most effective job . . . stamp out foam. Make your own test. Write for free sample of silicone defoamer. No obligation.
184 *Dow Corning Corporation

Furfuryl Alcohol.....Forms corrosion resistant resins, dissolves as well as reacts with many resins, & is a useful chemical intermediate. Bulletin 205.
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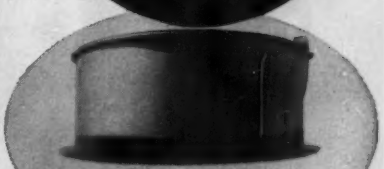

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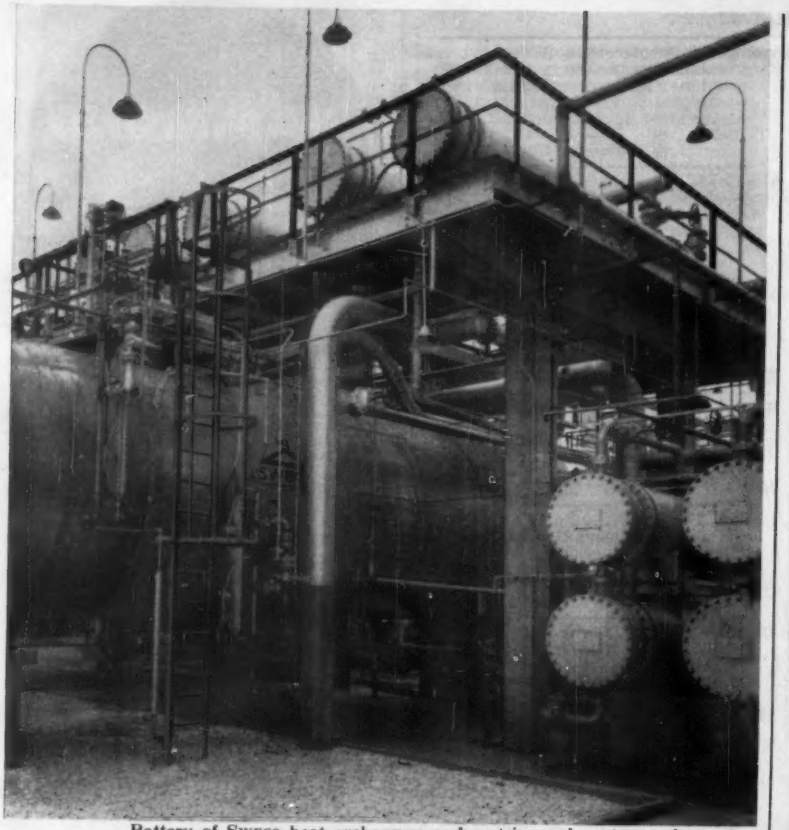

Battery of SWECO heat exchangers and a stripper decanter at the new W. R. Grace & Co., Polymer Chemicals Division, polyethylene plant in Baton Rouge, La. Plant was designed and built by the Fluor Corp., Ltd.

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188A Marblett Corp.

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38 *General American Transportation

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188B Wisconsin Protective Coatings.

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BL203 *Kerr Chemicals, Inc.

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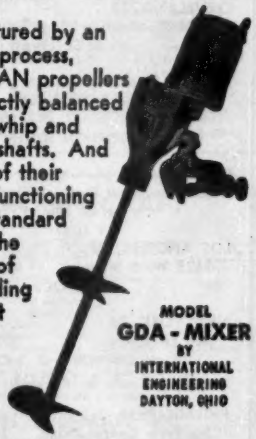

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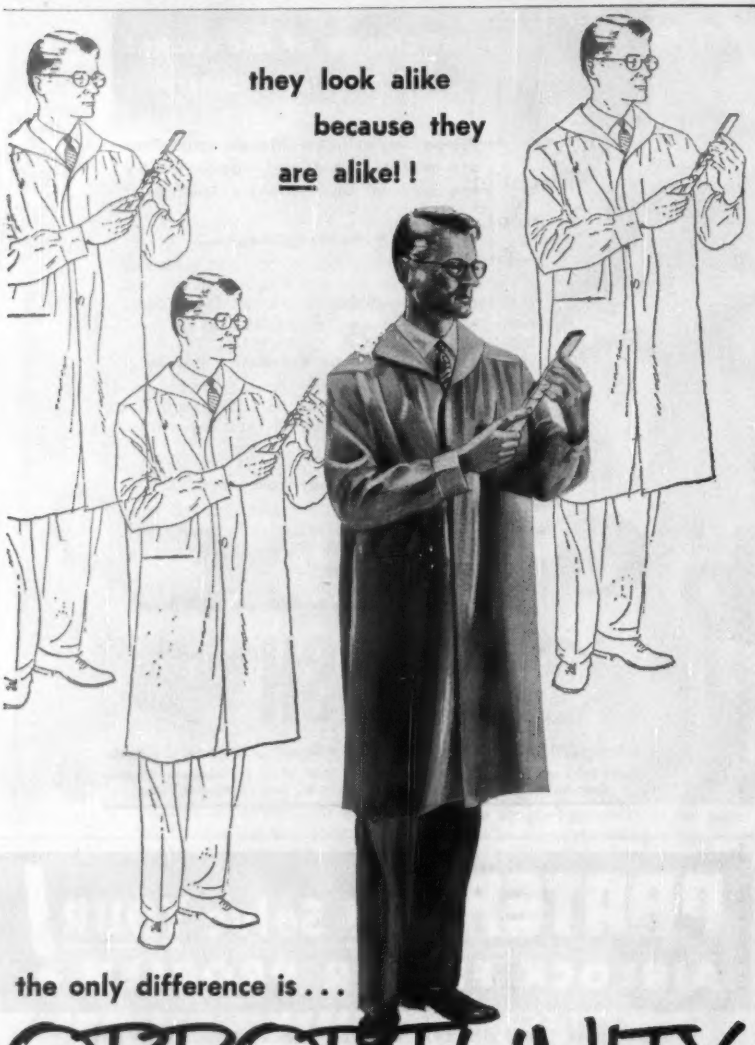

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3864 CFM	100-125 PSI 30-20½x14 Ing. PRE2 700 HP 3-60-2200

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Stokes 3-DDS2, 1-T, 1-RD3, 2-B
Baker Perkins 100 gal. S.S. double arm 50 HP jacketed, vacuum, hyd tilt.
Blaw Knox 2 gal. S.S. Autoclave 5000 lb.
50 gal. S.S. Autoclave 2000 lb. press.
Vulcanizer 60 in. x 9 ft. 125 lbs.
Oliver S.S. Pressure Filter.
Sweetland #2 all Stainless.
Stainless Steel Ball Mill.
Aluminum Condenser 350 sq. ft.
1—Aluminum evaporator, Calandria type, never used. 1300 sq. ft. tube area.
1—Baker Perkins 100 gal. double arm steel.
2—Proctor & Schwartz finned drum driers.
Continuous stripping column 2 x 13 steel.

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Size: 8 ft. Dia. x 124 ft. long
Thickness: ⅝" plate
Drive: 15 HP motor, 870 r.p.m., Westinghouse varied speed. Total reduction 378 to 1.
Speed: ½ r.p.m.

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PRescott 8-6640

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75 HP IR type ES-1, 426 CFM @ 100# cooler and vertical receiver. New 1956. 75 HP Schramm 315 CFM @ 125 PSI cooling system and 20 x 60 receiver.
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Devine #28 Vac. Shelf Dryers 59" x 78".
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2—6' x 45' Louisville Flame Dryers
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1—8' Sturtevant Whirlwhing Whizzer Air Separ.
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2—Sturtevant Size #2 type M.V. Screens, 3 HP
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1—P & L Dewatering Press, 7½ HP varidrive
1—Dupps Pre-Breaker, 25 HP motor
5—Pfaudler 1000 gal. Model R Reactors
2—1500 gal Steel agit. Reaction Kettles
2—Sharples Super Centrifuges, S.S. bowls
2—Rietz RD-18 S.S. Disintegrators, 100 HP
2—Moreley #4 Hammermills, 75 HP motors
1—42" x 68' Steel Bubble Cap Column
1—Oliver 8' x 10' Precoat Vac. Filter. Comp
1—A T & M 42" susp perf basket Centrifuge
1—Fitzpatrick Model J Homoloid Mill, S.S.
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MACHINERY and EQUIPMENT COMPANY Inc.
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Single & Rotary Tablet Machines ½" to 3".
Buffalo Vac. Drum Dryer 24" x 20".
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Centrifugals 12", 30", 40", & 48".
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Filter Presses 6" to 36" iron & wood.
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Sterling 8-1944

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DONORA, PA.

(In Conjunction with Kaiser Nelson Co.)

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2—Ruggles Cole 90" x 55' Class A14 Rotary Dryers, 7/16" shell.
1—Christie 80" x 65' type BV Rotary Dryer, ½" shell.
2—Herreshoff 20' dia., 16 hearth, Furnaces.
5—Dorrco Steel Rotary Filters, 14' x 8', 6' x 3', 6' x 2'.
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2—Swenson 6'6" dia. x 5' deep, steel, jacketed Vacuum Pans.
1—Blaw-Knox 1400 gal. steel, jacketed, agitated Vacuum Kettle.
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Troughing Belt Conveyors 18" to 48"; Bucket Elevators; Bins, 50 to 500 tons; Ball Mills; Jaw Crushers; Roll Crushers; Air Compressors.

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2—Pfaudler 1500 gal. glass lined, jacketed, agitated Reactors, 80# jacket, 50# internal.
1—1000 gal. nickel clad, jacketed, agitated Reactor.
1—Blaw-Knox 500 gal. 304 S.S. clad, jacketed, agitated Reactor.
2—Patterson 1000 gal., steel, jacketed, agitated Reactors, 20 HP.
1—Vulcan Briquetting Press, 30" dia. x 12½" face, 304 S.S. rolls, 50 HP.
1—3500 gal., 304 S.S. jacketed, agitated Tank, 9' x 7'.
1—Haveg 4000 closed Storage Tank.
2—5000 gal., 304 S.S. Horizontal Tanks, 6'6" x 20', Unused.
1—9400 gal., 316 S.S. Horizontal Tank, 8½' dia. x 19'.
1—20,000 gal. 304 S.S. Horizontal Tank, 10'6" dia. x 30'8" Unused.
4—Stainless Heat Exchangers, 1220, 1080, 786, 500 sq. ft.
1—Sharples C20 Super-D-Hydrator, 316 S.S., vapor tight, XP timers.
1—Sharples C27 Super-D-Hydrator, 316 S.S. 50 HP.
2—Sharples PN14 & PY14 Super-D-Canters, 304 S.S.
2—Bird 18" x 28", 24" x 38", stainless steel, solid bowl, continuous Centrifuges.
3—American 42" x 120" Double Drum Dryers, 10 HP motors.
3—Bird 40" suspended Centrifugals, 347 S.S., perforated basket, bottom discharge.
2—Buflovak, 250 & 20 sq. ft., 304 S.S. forced circulation Evaporator.
2—Feinc 5' x 6' stainless steel Rotary Vacuum Filters.
2—Sparkler 33-S-28 Pressure Filters, 150 sq. ft., 304 S.S.
1—Niagara 36 H-110 horizontal 304 S.S. Filter 110 sq. ft.
1—Baker Perkins #16 TRM, 150 gal., jacketed sigma blades, Vacuum Mixer, 60 HP motor.
1—Baker Perkins #15 VUMM, 100 gal. jacketed Mixer, dispersion blades, 100 HP motor.
1—Baker Perkins #15 JNM, 100 gal. jacketed Mixer, sigma blades.
3—Stokes R, single punch Tablet Machines, Unused.
1—Sweco 4' dia. double deck Screen, 316 S.S.

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Reactor, 125 gal. SS, Jktd. & Agtd. Exp. mtr.
Pfaudler 250 gal. Jkt. Kettle Ag't., Exp. mpr.
Baker Perkins 150 cu. ft. Jktd. Ribbon Mixer
Nash Hytor Vac. Pump #6, with 40 H.P. motor
Gen. American 42"x120" Twin Drum Dryer

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5—SS reactors, 750 gal., ASME 30# int. & jkt., 10 HP XP agit.

2—SS reactors, 125 gal., ASME 30# int. & jkt., 2 HP XP agit.

5—Pfaudler glass lined reactors 30, 100, 300 gal., jkt. & agit., ASME

1—T316 SS single effect evaporator, 26 sq. ft.

1—Rubber covered filter press, 24", 12 chambers

1—T316 SS rotary vac. filter, 18" dia. x 12" face

ALSO—tanks, suppository machines, tablet counters, Ertel filter, copper polishing pan, incubators, motors, pumps, etc.

STOCK ITEMS

ROTARY DRYERS

9' dia. x 30' long, SS lined, steel shell
8' x 70' Dbl. shell, Hardinge #XA-18
6' x 50' steam tube, Louisville
6' x 30' steam tube, Louisville
5'6" x 50' Renneberg, ⅜" x 5/16'
#604-24 Roto-Louvres, T316 SS
4'6" x 40' Ruggles-Coles, 5/16"
4'6" x 32' steel shell, ⅜"
4' x 30' Beaird #D-700
4' x 30' Dbl. shell, Tylor-Harmor #XC-2
4' x 24' brick-lined
4' x 12'6" Sturtevant, stainless
#310-16 Roto-Louvre, like new, steel
3' x 15', Everdur metal shell, ¼"

FILTERS, PRESSURE

510 sq. ft., vert., Niagara #510-28, T316 SS
151 sq. ft., Sparkler #33-S-28, T304 SS leaves
130 s. ft., horiz., Hercules #12, T304 SS leaves
110 sq. ft., horiz., Niagara #36H-110-3, T304 SS, 1954
45 sq. ft., vert., Niagara #45-30, T304 SS leaves
#12, #7, #5 Sweetland filters
P. & F. filter presses, up to 42", C.I., Ni-Resist, etc.

CRUSHERS

Double-roll, 24" x 24", Gruendler, 20 HP, 1954
Sawtooth, Robinson size #13, 15 HP
Gyratory, Kennedy #49S, 200 HP
Gyratory, Kennedy 12", 50 HP
Gyratory, McCulley 26"
Jaw, 8" x 10", Sturtevant
Jaw, 18" x 9", Mitchell, 25 HP

BRIQUETTING PRESSES

Komarek-Greaves, 27" dia. x 23" W rolls, 1¼" x 2¼" x 2¼" briquetts, 25 tons/hr., 75 HP motors.
Vulcan Iron Works, 30" dia. x 12½" W, T304 SS roll, 1-15/16" x 1⅛", 7½ tons/hr., 50 HP, 1954.
Komarek-Greaves, 16" dia. x 7½" W, walnut briquetts, 15 HP, 1953.

MILLS, PULVERIZERS

Hammermill, 400 HP, 47" x 60", Penna. crusher #5060, 1952, UNUSED
Hammermill, 60 HP, Penna. crusher #C-3-30
Coal pulverizer, 75 HP, Babcock & Wilcox #E-32
Roller mill, 66" Raymond low-side, 6 roll, 200 HP
Roller mill, 66" Raymond hi-side
Gyratory crusher, Kennedy #49S, 200 HP
Ring type granulator, 40 HP, Penna. crusher #K3-24

CONTINUOUS CENTRIFUGALS

Sharples C-20, C-27 Super-D-Hydrators, T316 SS, 1954
Sharples #AS-16, SS
Sharples #18-V, Tinned steel
Sharples #16, steel
Sharples #PY-14 Super-D-Canter, T316 SS
Bird 18" x 28", steel, horiz.
Bird 24" x 38", Monel, horiz.
Bird 40' x 60", T304 SS
Bird 24" x 24", monel slotted screen
Bird 40" x 60", T304 SS
Titan Super-jector, SS

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Mono- and Diethyl aceto acetic ester—Producer of this pharmaceutical intermediate would like to contact buyers. Write: Audichrome Productions, Inc., 342 Madison Ave., N. Y. 17, N. Y.

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CHEMICAL PROCESSING EQUIPMENT

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1—Stokes stainless steel rotary vacuum dryer, 3' x 15'
3—Pfaudler glass lined jacketed reactors, 150 gal. with anchor type agitators, complete.
2—Stokes Model T tablet presses

THE GELB GIRL—JULY 1958

CENTRIFUGES:

1—Fletcher stainless steel 48" suspended type centrifuge, with perforate basket, complete with motor and plow
1—Tolhurst 26" suspended type centrifuge, complete with motor, perforate basket.
1—Tolhurst SS 32" suspended type centrifuge, with perforate basket, complete with motor and plow.
1—AT&M 42" suspended type centrifuge, complete with type 347 SS perforate basket, plow and curb, with 40/20 HP motor.
1—Tolhurst 32" suspended type centrifuge with imperforate basket.
1—Tolhurst 40" center slung centrifuge with rubber covered perforate basket.
2—Tolhurst 48" center slung centrifuge with rubber covered perforate basket.

DRYERS:

4—Link Belt steel roto louvre dryers, Models 207-10-,310-16, 310-20, 604-20.
1—Buflovak double drum dryer, 42" x 120"
1—Stokes Model 59DS, steel rotary vacuum dryer, 5' x 30'
1—Bartlett & Snow rotary dryer, 4'6" x 36'6"
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
1—Louisville stainless steel rotary kiln, 30" x 28', complete.

FILTERS:

1—Oliver horizontal filter, 6'6"
1—Feinc stainless steel rotary string filter, 3' x 3' (NEW)
1—Oliver horizontal 3' pilot plant filter (NEW)
1—Sweetland #7 filter with 20 steel leaves.
10—Sweetland #12 filters with 72 SS leaves.
1—Sperry aluminum plate and frame filter press, 42" x 42", 33 chambers.
1—Sweetland #3 SS filter.
1—Niagara SS filter Model 510-28.

AUTOCLAVES, KETTLES & TANKS:

5—Pfaudler Series R, jacketed kettles, 1000 gals.
1—Glascote glass lined jacketed kettle, 500 gal.
1—Lee stainless steel jacketed kettle, 125 gals. 90# W.P.
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1—Gedge Gray SS ribbon blender, 65 cu. ft.
3—Robinson Type 316 SS sigma type jacketed heavy duty mixers, 400 gal. 60 HP.
1—J. H. Day SS jacketed double arm mixer, 1000 gals.
1—Baker Perkins SS jacketed double arm mixer, 500 gal. Type JEM, complete.

MISCELLANEOUS:

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1—6" x 12" 3 roll laboratory calender.
4—Type 317 SS heat exchangers, 892 sq. ft. each, 200 PSI.
1—Combustion Engineers, water tube package boiler, 200 HP, 375# pressure.
30—Struthers Wells SS heat exchangers, 650 sq. ft. each.
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1—Ingersoll Rand Compressor, 1600 CFM, 100#, with 300 HP motor.
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1—Sweco Type 316 SS 48" separator.

1—J. H. Day high speed 3 roll mill, 9" x 24"
1—Baker Perkins Type 316 stainless steel Ter Meer centrifuge, Model HS-24"
1—Struthers Wells Type 316 stainless steel heat exchanger, 330 sq. ft.
1—Leader stainless steel jacketed ribbon blender, 51 cu. ft.

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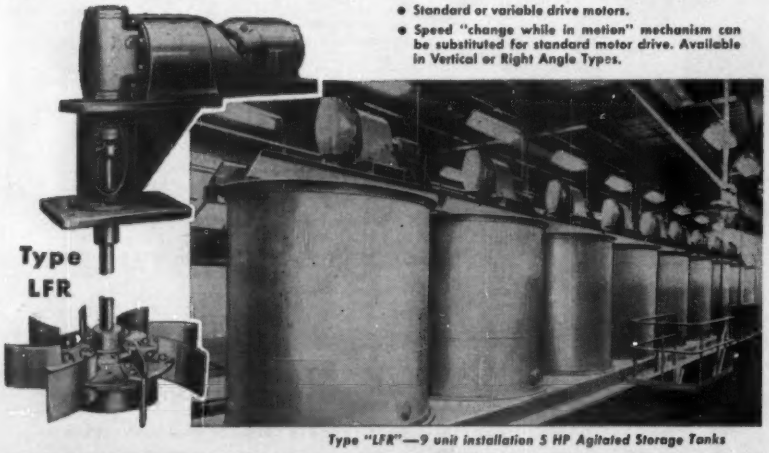

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How a *Paracoil* "clean shave" gives you better heat transfer

Back and forth go the baffles . . . like blades . . . along the tube surfaces . . shaving away accumulations of fouling materials . . cleaning the heat exchanger . . . and giving process plants continuous, increased and better heat transfer.

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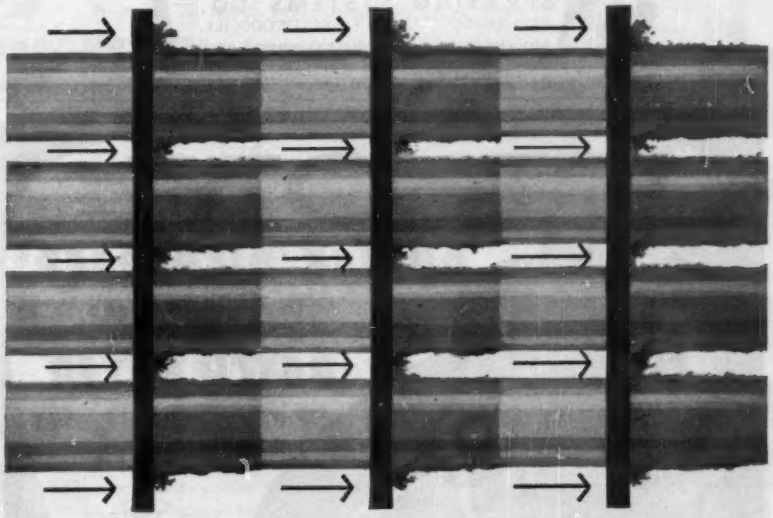
If you have a fouled heat exchanger problem, we may have the answer.



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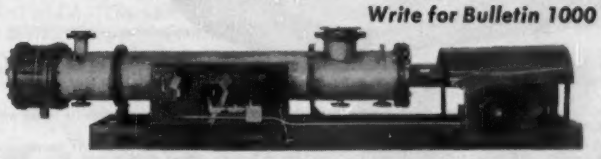

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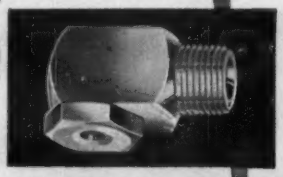

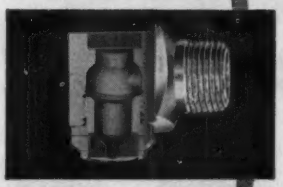

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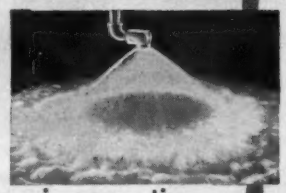

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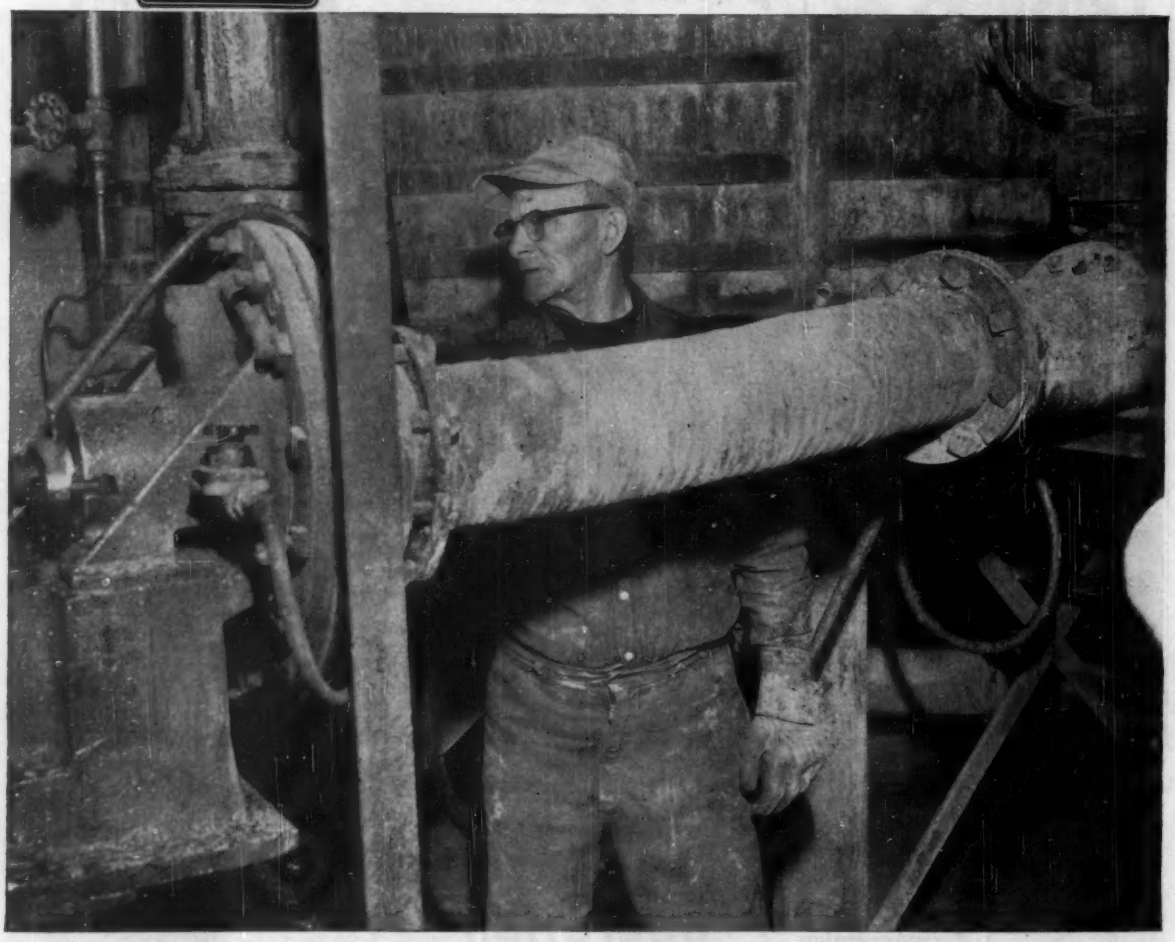

Bang, rattle, shake—pipes were cracking up

B. F. Goodrich improvements in rubber brought extra savings

Problem: That powerful pump at left draws hot acid at 400 gallons a minute from tanks, then shoots it through big pipes. The pump vibration shook the pipes until they clanged, rattled and shivered, gradually cracked, leaked, lost corrosive acid that damaged equipment. Pipes had to be replaced two or three times a year.

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Where to buy: Your B.F.Goodrich distributor has exact specifications for the B.F.Goodrich hose described here. And, as a factory-trained specialist in rubber products, he *can* answer your questions about *all* the rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Company, Dept. M-386, Akron 18, Ohio.*

B.F.Goodrich *industrial products*

Pictured above are Sidney A. Lewis of the Walworth Sales Staff, Lewis A. Crabb of Machlett Laboratories and Jack I. Hoffman of the Connecticut Plumbing Supply Company, discussing plans for a new and complex piping installation. The smaller view shows a few of the lines for which Walworth PVC Valves and Fittings were selected.

"We can count on Walworth for personal attention"

Says Lewis A. Crabb, chief maintenance engineer of Machlett Laboratories, Springdale, Conn.

When the Machlett Laboratories faced a specialized problem in the piping of waste acids of all types, including those used for etching, they needed more than fine valves and fittings. They required the kind of personal help and advice that comes only with sound experience.

Sidney A. Lewis, of the Technical Sales staff of Walworth sat down with Mr. Crabb, studied the problem and helped to select the exact Walworth equipment that would give the best possible service.

Backing up Walworth products with friendly capable technical help is regular procedure with all of our staff. On your next problem involving valves and fittings, call Walworth.

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DORR-OLIVER designed, engineered and supplied all equipment for this 600-ton/day triple superphosphate plant of American Cyanamid Company at Brewster, Fla. Phosphoric acid is produced in the reactor tanks at right of open-air building. Premixers, reactors, small tank and sump in foreground are all equipped with LIGHTNIN Mixers.

What helped this Cyanamid plant **exceed design capacity** *in less than three months?*

200,000 tons a year of triple superphosphate fertilizer—that's the record-breaking production at this American Cyanamid Company plant.

Designed, engineered and equipped by Dorr-Oliver Incorporated, the plant reached its design capacity and guaranteed yields less than three months after initial startup.

How did they do it?

One part of the answer is good mixing. Three of the major operations—reaction, evaporation, water reclamation—employ LIGHTNIN Mixers.

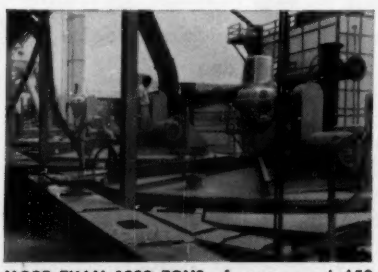
Optimum reactor yield

Every day, over 700 tons of phosphate rock and 600 tons of 98% sulfuric acid flow into the plant's two big premixers and four reactors. One 30-horsepower and five 60-horsepower turbine-type LIGHTNIN Mixers provide the intense but controlled agitation necessary to obtain maximum yields of 32% P_2O_5 phosphoric acid and coarse, uniform, fast-filtering gypsum.

In the three-stage vacuum evaporator system, turbine-type LIGHTNINs keep the three seed tanks uniformly mixed.

Contaminated water at 3200 GPM is neutralized in two LIGHTNIN-equipped tanks, clarified in a 90-foot diameter Dorr Clarifier, cooled and reused, while acid wastes are neutralized in two other LIGHTNIN-mixed tanks prior to discharge.

"Good mixing" is the reason why Dorr-Oliver purchased LIGHTNIN Mixers throughout this record-toppling plant—and why LIGHTNINs are used in many plants designed by this experienced firm.



MORE THAN 1000 TONS of gypsum and 650 tons of 32% P_2O_5 phosphoric acid a day are handled by one 30-HP and five 60-HP LIGHTNINs, largest mixers ever used for this purpose.

TURBINE-TYPE LIGHTNINs in the seed tanks of American Cyanamid's vacuum evaporator station concentrate phosphoric acid from 32% to 54% P_2O_5.

What this can mean to you

How important is good mixing in *your* process? For mixers that can help you get a new plant onstream faster . . . give you *guaranteed* answers to mixing problems . . . and trim fluid mixing costs to a minimum—see your LIGHTNIN Mixer representative. He's listed in Chemical Engineering Catalog. Or write us direct.

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- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-g Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 19, Ont.

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MIXCO fluid mixing specialists